Tennessee Valley Authority

Division of Environmental Planning
Water Quality and Ecology Branch

STATUS OF THE NONRADIOLOGICAL WATER QUALITY AND NONFISHERIES BIOLOGICAL COMMUNITIES IN THE CLINCH RIVER PRIOR TO CONSTRUCTION OF THE CLINCH RIVER BREEDER REACTOR PLANT 1975-1978

Prepared By

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Chattanooga, Tennessee
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I. Introduction

I. Introduction

The Tennessee Valley Authority (TVA), a corporate agency and instrumentality of the United States Government, announced in January 1972 that it would be involved in a joint proposal to work with the Atomic Energy Commission (now ERDA) and Commonwealth Edison Company of Chicago to design, develop, construct, and operate the first Liquid Metal Fast Breeder Reactor (LMFBR) demonstration plant in the United States. The site selected was TVA property on the Clinch River in east central Tennessee. TVA as part of its commitments to the project agreed to be responsible for environmental monitoring of the site during the construction and operation phases.

In accordance with the National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. Section 4331 et seq) the U.S. Nuclear Regulatory Commission (NRC) prepared a draft Environmental Statement (DES) which was sent to the Council of Environmental Quality (CEQ), made available to the public, and circulated for review and comment to other Governmental agencies in February 1976. The final Environmental Statement (FES) was sent to CEQ and made available to the public in February 1977. The FES was based on the information provided in the Environmental Report (ER) which was issued in April 1975 for the Clinch River Breeder Reactor Plant (CRBRP).

The ER included a description of a nonradiological water quality and aquatic biology (nonfish) preconstruction - construction effects monitoring program, which was implemented in March 1975. This program was based primarily on a continuation of many of the features of the baseline aquatic monitoring program conducted during the period March

1974 through April 1975. The program was reviewed and revised by TVA in January 1976 to reflect a more comprehensive site-specific preconstruction effects monitoring program. The revised program was conducted during the period March 1976 through October 1977. In January 1978, ERDA requested that all aquatic monitoring at the site be discontinued, except for the peripheral stormwater runoff monitoring activity, which was to continue through October 1978.

This report presents the results of the Clinch River Breeder Reactor Plant preconstruction nonradiological water quality and nonfisheries biological communities monitoring program for the period March 1975 through October 1978.

II. Site Characteristics

II. Site Characteristics

II.A. Site Location, Land Use, and Wastewater Discharges

The Clinch River site is located in east central Tennessee in the eastern part of Roane County (Figure II.A.1) on a peninsula formed by a meander between Clinch River miles (CRM) 14.5 and 18.6. Opposite the site (left bank) Caney and Poplar Springs Creeks enter the Clinch River at CRM 16.9 and CRM 16.2, respectively (Figure III.2, page 14).

Steep limestone ridges, hills, and knobs are characteristic features of the site region. A flood plain borders the western side and the southern tip of the peninsula, but is essentially absent from the eastern border. There are no perennial streams on the site; flow along valleys and gullies occurs only after periods of rainfall.

Within a 3.2 km (2 mi) radius of the site, the area consists primarily of woodland with small farms and residences scattered throughout the area south of the river. There are three major industrial activities located within 8 km (5 mi) of the site: (1) the ERDA Oak Ridge Gaseous Diffusion Plant, (2) ERDA Oak Ridge National Laboratory, and (3) Clinch River Consolidated Industrial Park. The first two of these facilities, along with the TVA Kingston Steam Plant, which is about 9.7 km (6 mi) from the site, are the most significant sources of wastewater discharged to the river in the site vicinity (Table II.A.1 and Figure III.1, page 13).

The Clinch River between miles 4.4 and 20 has been classified by the Tennessee Division of Water Quality Control as being suitable for all designated uses (1-7)*, except for the reach between miles 12 and 20,

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*Domestic Raw Water Supply, 2 - Industrial Water Supply, 3 - Fish and Aquatic Life, 4 - Recreation, 5 - Irrigation, 6 - Livestock Watering and Wildlife, and 7 - Navigation.

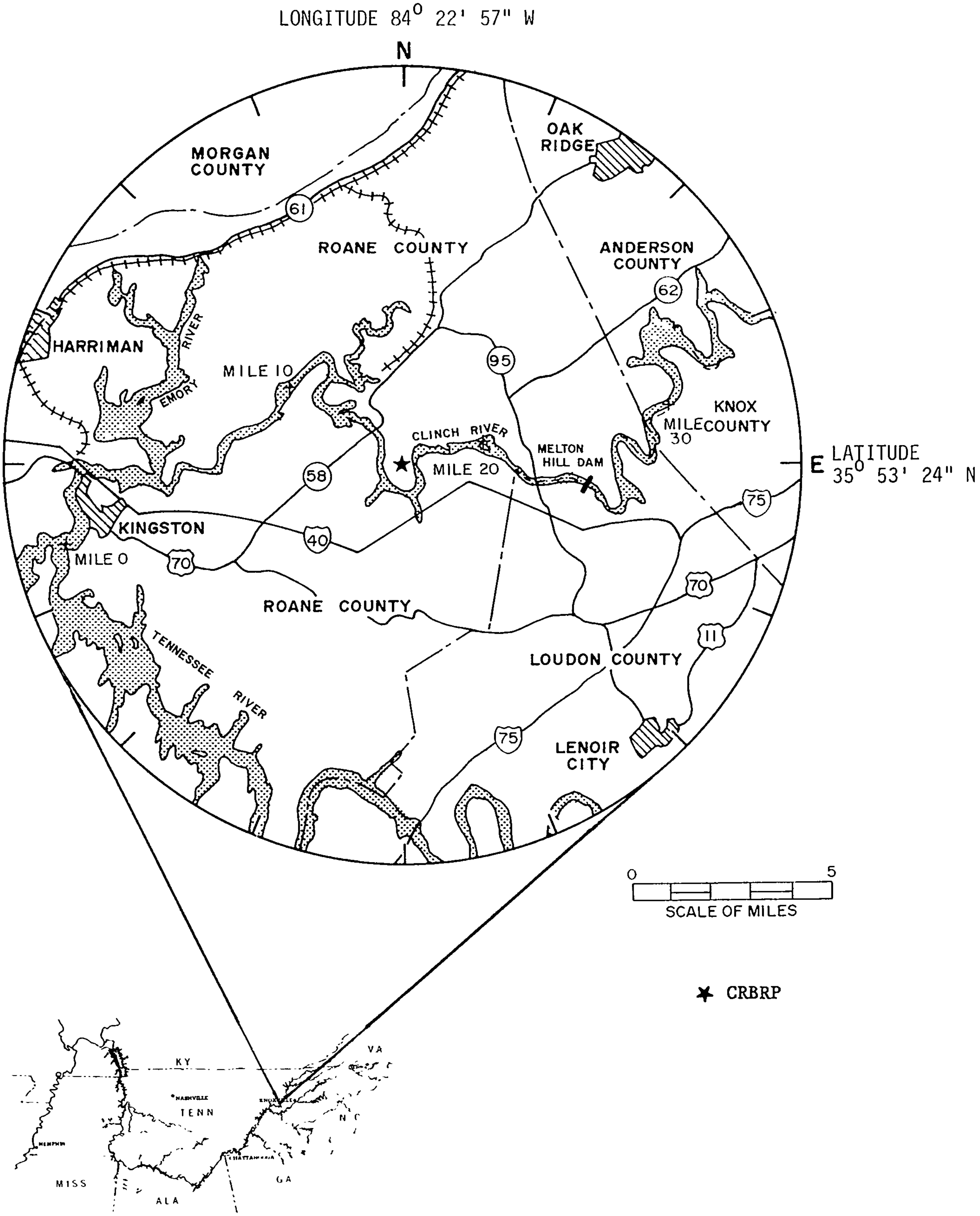


FIGURE II. A.1. LOCATION OF CLINCH RIVER BREEDER REACTOR SITE

Table II.A.1

SIGNIFICANT WASTEWATER DISCHARGES IN THE VICINITY OF THE CLINCH RIVER BREEDER REACTOR PLANT
(CRM 0.0 to CRM 23.1)

Name	Source	Volume (MGD)	Effluent Characteristics*	Outfall Location (Stream Mile)
U.S. ERDA-Oak Ridge Gaseous Diffusion Plant	001 (process, runoff, subsurface drainage)	1.14 -1.64	pH (9.5), Al (0.05-1.5), COD (3-13), Cr (0.08-0.28), TDS (201-379), F (0.3-0.84), NO_3 (2-25), Oil-Grease (1), SS (6.3-18), Turb (7.3-8.5 JTU), Zn (0.1-0.5), Temp (50-67°C)	Poplar Ck. 4.5 (CR 12.0)
	002 (metal plating)	0.002	pH (6.2-6.6)	Poplar Ck. 2.7
	004 (steam condensate)	0.004	COD (5-15), pH (8.8), Temp (42-46°C)	Poplar Ck. 2.5
	005 (sanitary)	0.642	-	Poplar Cr. 1.7
	006 (cooling water blowdown, runoff)	2.03	Cl_2 (1.2), COD (11.8), Cr (0.2 μg/l), Fl (0.66), Oil-Grease (1.7), SS (10.8), pH (7.0-8.9)	Poplar Cr. 1.5
	007 (cooling water blowdown)	2.2 -5.7	COD (7-13), Cr (0.9-1.4), Fl (0.2-0.3), Oil-Grease (1.0-1.5) SS (10-16), Turb (10 JTU), pH (8.3-9.0), Zn (0.4), D.O. (9.5-11.3), Cl_2 (<0.05), Temp. (1.5-3.0°C)(above background)	CR 11.4
	008 (sanitary)	0.012-0.02	BOD (2.0-2.5), SS (5-26), pH (6.7-8.6), Res. Cl_2 (1.0)	CR 13.2
	009 (water treatment sludges, filter backwash)	0.108	SS (190-1204), Al (2.5-1000), SO_4 (18-37), COD (16), pH (6.0-7.8)	CR 14.5
U.S. ERDA-Oak Ridge National Laboratory	001 (cooling, cooling tower blowdown, demineralized wastes, radioactive wastes, runoff)	5.3 -16.7	BOD (4-6), COD (<12.7), Cr Tot. (0.01-0.2), TDS (136), Oil-Grease (1-4), pH (<4.5->9.5), SS (<4-<98)	White Oak Cr. 1.6 (CR 20.9)
	002 (cooling tower blowdown, runoff)	1.3 -2.9	BOD (1.8), COD (<10), Cr (0.4-1.0), TDS (136-310), pH (<4.5->9.5), SS (5-35), Oil-Grease (1-3)	Melton Br. 0.1 White Oak Cr. 1.5
	003 (sanitary)	0.12 -0.21	BOD (8-27), NH_3-N (1-13), pH (7.3), SS (18-37), Res. Cl_2 (1.3)	White Oak Cr. 2.3
	004 (sanitary waste)	0.006	NH_3-N (2.0-4.9), BOD (6-25), Res. Cl_2 (1.0), pH (7.1), SS (8)	Melton Br. 0.9 White Oak Cr. 1.5
USTVA-Kingston Steam Plant	001 (ash sluice, sanitary, chemical cleaning, coal runoff)	21.9	NH_3-N (0.06), SS (41), pH (3.3-8.8), Fe (75#/D), Cu (8.2#/D), Se (0.4#/D), Mn (57.6#/D), As (4.9#/D) lbs/d	Emory R 2.4 (CR 4.4)
	002 (condenser cooling water, intake screen back wash, boiler blowdown, floor drainage)	1193	Temp. Rise (13°F), Tot. Sol. (1,500 #/D)	CR 2.6
	003 (coal runoff)	0.007		CR 2.6

*Units are mg/l, unless otherwise noted.

which was not classificated for navigation. In the vicinity of the site the river (CRM 0.0 to CRM 23.1) is designated as a water quality limited segment presently violating water quality standards (i.e., reported violations of temperature and coliform standards in the Kingston area - CRM 0.0 to 5.0).

II.B. River Flow and Morphology

At the site, the Clinch River is part of Watts Bar Reservoir which is formed by Watts Bar Dam at TRM 529.9 about 89 river km (55 mi) downstream of the site. Flow and water level of the river at the site is regulated by the operations of TVA's Melton Hill, Fort Loudoun, and Watts Bar Dams.

By the operation of the three dams, TVA generally maintains a pool elevation between 225.5 m (740 ft.) and 225.8 m (741 ft.) MSL during the spring and summer months and a winter pool elevation of 224.0 m (735 ft.) to 224.6 m (737 ft.) MSL for the remainder of the year. Water level at the site has a normal range of approximately 1.8 m (6 ft.) during the year. At a river elevation of 224.6 m (737 ft.) MSL, the maximum depth of the Clinch River between CRM 15 and 18 ranges from 4.9 m (16 ft.) to 7.9 m (26 ft.).

River velocity in the site vicinity is highly variable ranging from 0 to 0.9 mps (0 to 3 fps). Since the closing of Melton Hill Dam (1963 to 1978), the average annual daily discharge from the dam has been 1,533 smd (5,030 sfd). The maximum hourly discharge during the period was 1,556.5 cms (54,960 cfs) and the maximum daily average discharge was 990.2 cms (34,966 cfs).

An evaluation presented in the CRBRP ER, showed that since the closure of Melton Hill Dam, there has been an average of 46 days per year during which no water was released from the dam. Eighty-three percent of the zero release periods (1963 to 1972) were limited to 48 hours or less. Extended periods of zero discharge has occurred in the past as a result of a special operational request to assist in the control of Eurasian water milfoil, however, such periods are not routine events. Upstream (reversed) flows in the Clinch River at the site occur during these periods of no release from the dam. Studies have indicated that upstream velocities on the order of 0.3 mps (1 fps) can occur at the site.

During the monitoring period (1975-1977) the average annual daily discharge from Melton Hill Dam was 1,744 smd (5,723 sfd). The maximum hourly discharge and maximum daily discharge were 1,556.5 cms (54,960 cfs) and 942.3 cms (33,273 cfs), respectively. Appendix C provides the daily discharge records for Melton Hill Dam for the years 1975, 1976, and 1977. Table II.B.1 lists the occurrences and duration of extended periods of zero release (greater than 48 hours) from Melton Hill Dam during the monitoring period.

At the site, the width of the Clinch River ranges from approximately 91 m (300 ft.) to 183 m (600 ft.). There are midriver sand-gravel bars from approximately CRM 15.6 to CRM 16.1 where the river widens to about 183 m (600 ft.). River bed slope averages about 0.5 m (1.5 ft.) per 1.6 river km (1 mi). In the site area, CRM 15 to CRM 18, the shorelines are moderately steep. During periods of elevated river stage, tree branches and other vegetation are partially submerged and overhang the edges of the river thus forming dense cover along most sections of the river shoreline.

Table II.B.1

Extended Periods of Zero Release From Melton Hill Dam
During the Monitoring Period
(1975-1977)

Year	Number of Hours of Zero Release	Period of Zero Release
1975	82	1 a.m., 9/24 - 10 a.m., 9/27
	69	11 a.m., 10/20 - 7 a.m., 10/23
	58	9 p.m., 10/24 - 5 a.m., 10/27
	83	8 p.m., 11/16 - 6 a.m., 11/20
	79	12 mdt., 12/12 - 6 a.m., 12/16
1976	61	6 p.m., 2/13 - 6 a.m., 2/16
	75	2 p.m., 3/27 - 4 p.m., 3/30
	86	11 p.m., 5/17 - 12 m., 5/21
	70	7 p.m., 7/2 - 4 p.m., 7/5
1977	80	11 p.m., 2/24 - 6 a.m., 2/28
	71	9 a.m., 3/7 - 7 a.m., 3/10
	139	10 p.m., 3/25 - 4 p.m., 3/31

II.C. Site Hydrogeology

The most important aquifers in the valley and ridge province in eastern Tennessee are carbonate rocks. The valley and ridge section of Roane County, where the site is located, is characterized by parallel ridges and valleys. The ridges are underlain by cherty dolomites of the Knox Group and the valleys are underlain by limestones or shale, each of which weathers more rapidly than do the dolomites.

The Knox Group and the lower and middle parts of the Chickamauga Group comprise an aquifer system of carbonate rocks in the site vicinity. The Clinch River is a ground water sink; discharge from the aquifer system goes directly into the river or into streams which flow into the river. Ground water flow passing under the river is unlikely. Ground water recharge is primarily derived from precipitation, although it is possible that in some restricted areas recharge may occur from the river during periods of rapid increase of river stage.

Generally, ground water at the site is found in weathered joints and fractures in the underlying rocks and is under unconfined water table conditions (ground water subject to atmospheric pressure). The ridges, which cross the site peninsula, represent locations of ground water highs, provide boundaries to local aquifer systems, and are regarded as approximate locations of ground water divides.

The permeability of the underlying rocks at the plant site is mostly less than 244 m (800 ft.) per year, ranging from zero to 460 m (1510 ft.) per year. Movement of ground water is from topographic highs to topographic lows and is largely restricted to the upper more weathered zones of the underlying rock.

Ground water levels over the site are related to depths of weathering (lower ground water levels occurring in zones of greatest depth of weathering and consequently higher permeability) and only incidently related to surface topography. Response of the water table to precipitation is rapid, which is indicative of rapid recharge. The rapid recharge probably occurs in areas of exposed rock and small sink holes along the ridges at the site.

III. The Preconstruction Aquatic Environmental Monitoring Program (Nonradiological and Nonfish)

III. Preconstruction Aquatic Environmental Monitoring Program

The construction effects monitoring was initiated in March 1975. This program was based primarily on a continuation of many of the features of the comprehensive baseline aquatic monitoring program conducted during the period March 1974 through April 1975, which is discussed in detail in the CRBRP ER, section 2.7.2.

This initial program, which was conducted during the period March 1975 through October 1975 included the monitoring of Clinch River water chemistry, phytoplankton, periphyton, zooplankton, and benthic macroinvertebrate communities. Also, special surveys were conducted to monitor the impact of runoff from the site on Clinch River water quality. The composite program is summarized in tabular form in Table III.1 and the sampling stations are shown in Figures III.1 and III.2.

The construction effects monitoring program was revised in January 1976 to reflect a more comprehensive site specific construction effects monitoring program. This program was not designed to be a continuation of the baseline monitoring program or as a preoperational monitoring program. This site specific montoring program is summarized in tabular form in Table III.2 and the sampling stations are shown in Figures III.1, III.3, and III.4.

Data available from other related programs in the project area as described in Section 6.3 of the ER, is available for water quality (non-biological) trend assessment relative to the baseline conditions and preoperational conditions. In this report data from the TVA Regional Water Quality Management Monitoring Network station at Melton Hill Dam tailrace (CRM 23.1) was utilized for this trend assessment purpose.

Although not identified in the ER, a monitoring station maintained by the Tennessee Division of Water Quality Control is located at CRM 10.0R. Samples are collected at 0.3 M (1 ft) at 90 percent for the left bank (facing the downstream direction). This data was reviewed and discussed in this report.

Table III.1

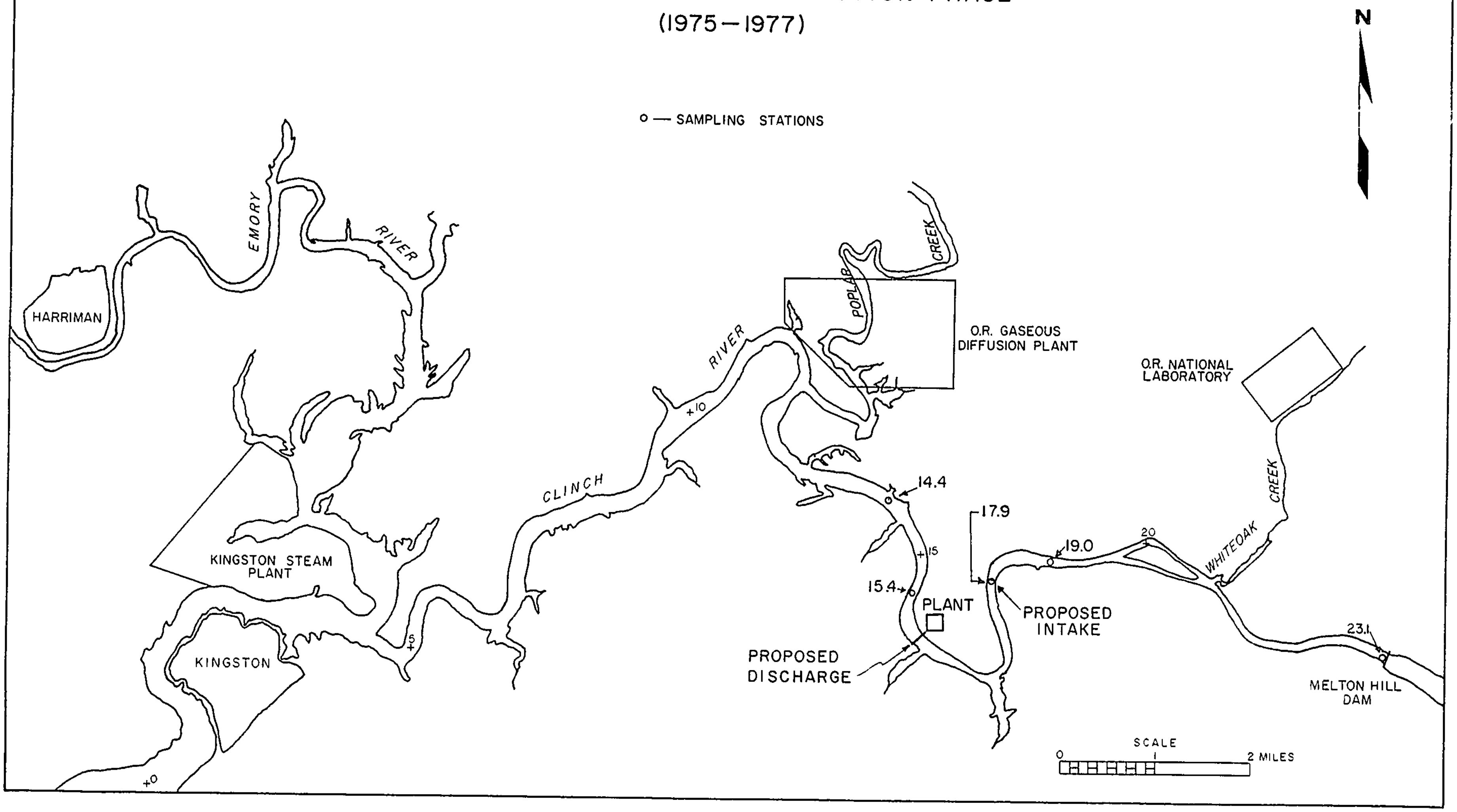
PRECONSTRUCTION AQUATIC (NONFISH - NONRADIOLOGICAL) ENVIRONMENTAL MONITORING PROGRAM
CLINCH RIVER BREEDER REACTOR PLANT SITE
(Monthly March through October 1975)

Physical-Chemical					Biological						
Station Location	Horizontal[1] Location	In Situ[2] (meters)	Laboratory[3] (meters)	Stormwater Runoff[4]	Coliform[3] (meters)	Phytoplankton and Chlorophyll[5] (meters)	Submarine Photometer (meters)	Zooplankton[6] (meters)	Autotrophic-Heterotrophic (Indices) (Periphyton)[7] (meters)	Benthos (Artificial Substrate)[8]	Benthos (Dredge)[9]
CRM 23.1	20			X							
CRM 19.0	50	0.3,1,1.5,3,5,6	1,3,5	X	1,3,5	0.1,1,3,5	0.1,1,3,5	X	X	X	X
CRM 17.9	50	0.3,1,1.5,3,5,6	1,3,5	X	1,3,5	0.1,1,3,5	0.1,1,3,5	X	X	X	X
	5,25,75,95			X							
CRM 15.4	50	0.3,1,1.5,3,5,6	1,3,5	X	1,3,5	0.1,1,3,5	0.1,1,3,5	X	X	X	X
	5,25,75,95			X							
CRM 14.4	50	0.3,1,1.5,3,5,6	1,3,5	X	1,3,5	0.1,1,3,5	0.1,1,3,5	X	X	X	X
Caney Creek 0.01 (CRM 16.9L)	50			X							
Poplar Springs Creek 0.01 (CRM 16.2L)	50			X							
Grassey Creek 0.01 (CRM 14.5R)	50			X							
Tributary 0.01 (CRM 14.6L)	50			X							

[1]Percent from the left bank, facing the downstream direction.
[2]Measurements made In situ for dissolved oxygen, pH, temperature, and conductivity.
[3]Measurements made for alkalinity (field), solids, colors, turbidity, coliform, BOD, COD, Carbon (TOC and SOC), nitrogens, phorphorus, Fe, Na, K, Ca, Mg, Cl, SO_4, SiO_2, Cd, Cr, Cu, Mn, Pb, Hg, Ni, and Zn.
[4]Samples collected at surface for pH (field), turbidity, and suspended solids determination. Additional samples collected in March, May, June, September, and October during rainfall events.
[5]Phytoplankton collected for cell enumeration and percentage composition by major taxonomic group. Chlorophyll a estimate of biomass standing crop.
[6]Zooplankton sampled by vertical tows for species identification and composite biomass determination.
[7]Artificial periphyton substrates (4-week exposure) for autoheterotrophic index and percentage composition of major taxonomic groups.
[8]Artificial substrates for benthos, samples used to quantify biomass, numbers, and diversity.
[9]Dredge for benthos and particle size analysis, samples used to quantify biomass, numbers, diversity, and substrate type.

FIGURE III.1

SAMPLING LOCATIONS FOR WATER QUALITY MONITORING
CLINCH RIVER BREEDER REACTOR PLANT
PRECONSTRUCTION-CONSTRUCTION PHASE
(1975—1977)



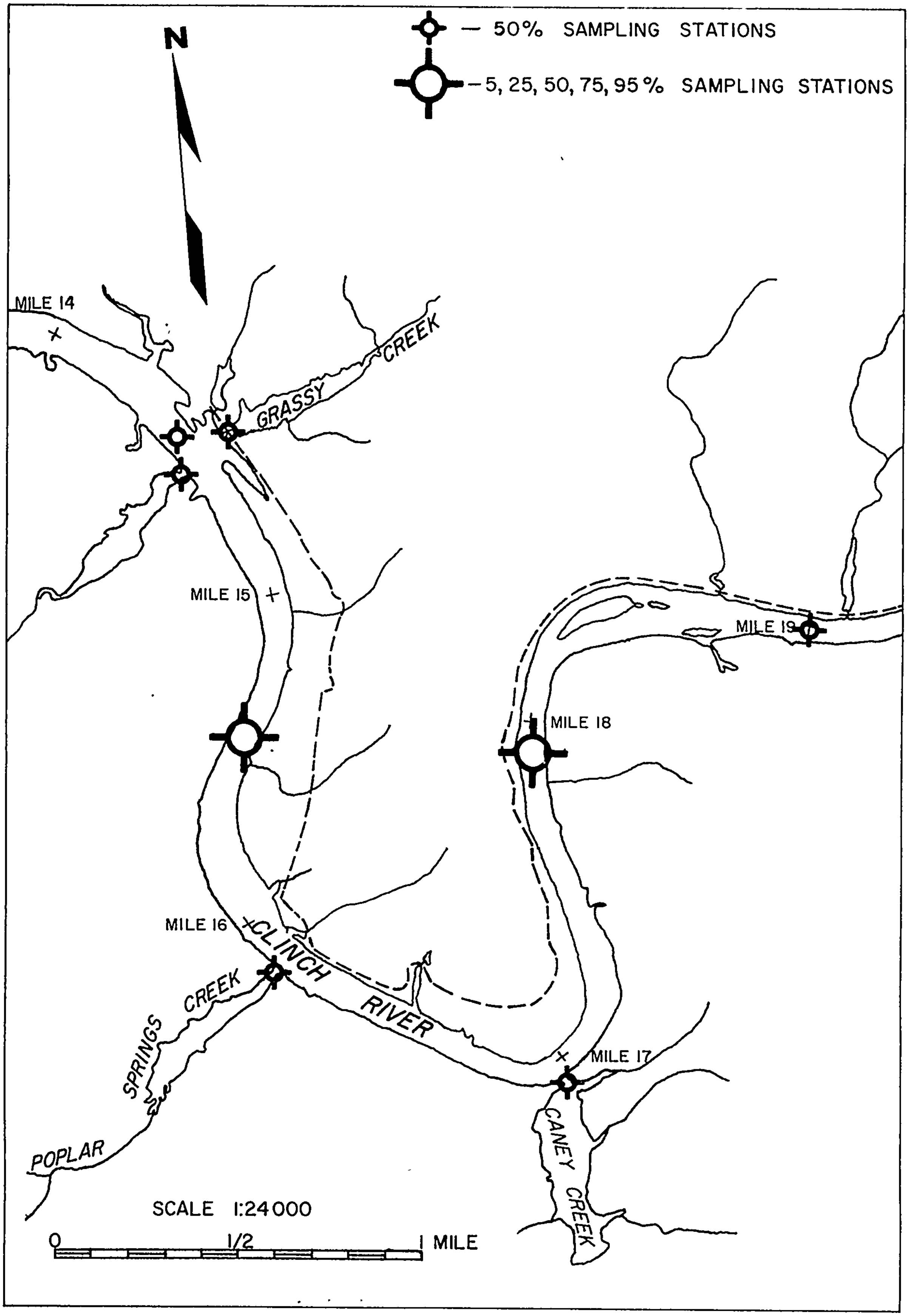


FIGURE III.2 CLINCH RIVER SAMPLING STATIONS FOR SITE STORMWATER RUNOFF, CRBRP - 1975

Table III.2

PRECONSTRUCTION AQUATIC (NONFISH-NONRADIOLOGICAL) ENVIRONMENTAL MONITORING PROGRAM
CLINCH RIVER BREEDER REACTOR PLANT SITE
(1976-1978)

Station Location	Horizontal Location[1]	Physical-Chemical: In Situ[2] Meters	Physical-Chemical: General[3] Meters	Physical-Chemical: Comprehensive[4] Meters	Physical-Chemical: Fecal Coliforms[1] Meters	Biological: Primary Productivity (In Situ C^{14})[5] Meters	Biological: Submarine Photometer[5] Meters	Biological: Benthos (Artificial Substrates)[6]	Biological: Benthos (Dredge)[7]
CRM 19.0	50								X
	95							X	
CRM 17.9	50	0.3,1,1.5,3, 5,6	1,3,5	1,3,5	0.1	0.1,1,3,5	0.1,1,3,5		X
	5	(0.3,1,1.5,3)[8]				0.1,1,3	0.1,1,3		
	95	(0.3,1,1.5,3)[8]				0.1,1,3	0.1,1,3,5	X	
CRM 15.4	50	0.3,1,1.5,3, 5,6	1,3,5			0.1,1,3,5	0.1,1,3,5		X
	5	(0.3,1,1.5,3)[8]				0.1,1,3	0.1,1,3		
	95	(0.3,1,1.5,3)[8]				0.1,1,3	0.1,1,3	X	
CRM 14.4	50	0.3,1,1.5,3, 5,6	1,3,5	1,3,5	0.1	0.1,1,3,5	0.1,1,3,5		X
	5	(0.3,1,1,5,3)[8]				0.1,1,3	0.1,1,3		
	95	(0.3,1,1.5,3)[8]				0.1,1,3	0.1,1,3	X	
Peripheral Stormwater Runoff									
CRM 15.5	0.4[9]			S[10]					
CRM 15.95	0.1			S					
CRM 16.10	0.2			S					
CRM 16.50	2.4			S					
Groundwater									
Well A-58				X[11]					
Well E-60				X					
Well R-62				X					
Well G-68				X					
Well A-70				X					
Well N-70				X					
Well- Auto Sampled				X					

[1]Percent from the left bank, facing the downstream direction.
[2]Measurements made *in situ* for dissolved oxygen, pH, temperature, and conductivity once during months of January, and March through October.
[3]Measurements made for alkalinity (field), nitrogens, phosphorus, COD, TOC, solids, turbidity, and colors once during months of January and March through October.
[4]Measurements made for BOD, fecal coliform, Cd, Ca, Cl, Cr, Cu, Fe, Pb, Mg, Mn, Hg, Ni, K, SiO_2, Na, SO_4, and Zn once during months of January, April, July, and October.
[5]Primary productivity (*in situ* C_{14} uptake) and submarine photometer (percent light perbiastion) measurements made once during months of March through October.
[6]Artificial Substrates for Benthos - two month exposures. Placed in during months of March, May, July, and September and removed in May, July, September, and November. Samples used to quantify biomass, numbers, and diversity.
[7]Dredge for Benthos and particle size anlaysis once during months of March, May, July, and September. Samples used to quantify biomass, numbers, diversity, and substrate type.
[8]Initiated in June 1977.
[9]Kilometers from mouth of drainage ways all located at 100 percent from left bank, facing the downstream direction.
[10]Samples analyzed for pH and temperature in the field, and suspended solids and turbidity in the laboratory. Sampling initiated in June 1976 on a monthly basis.
[11]Samples analyzed for pH and temperature in the field and conductivity, alkalinity, P, solids, Na, SO_4, B, Cd, Cr, Cu, Pb, Mn, Ni, and Zn in the laboratory. Sampling initiated in June 1976 on a quarterly basis.

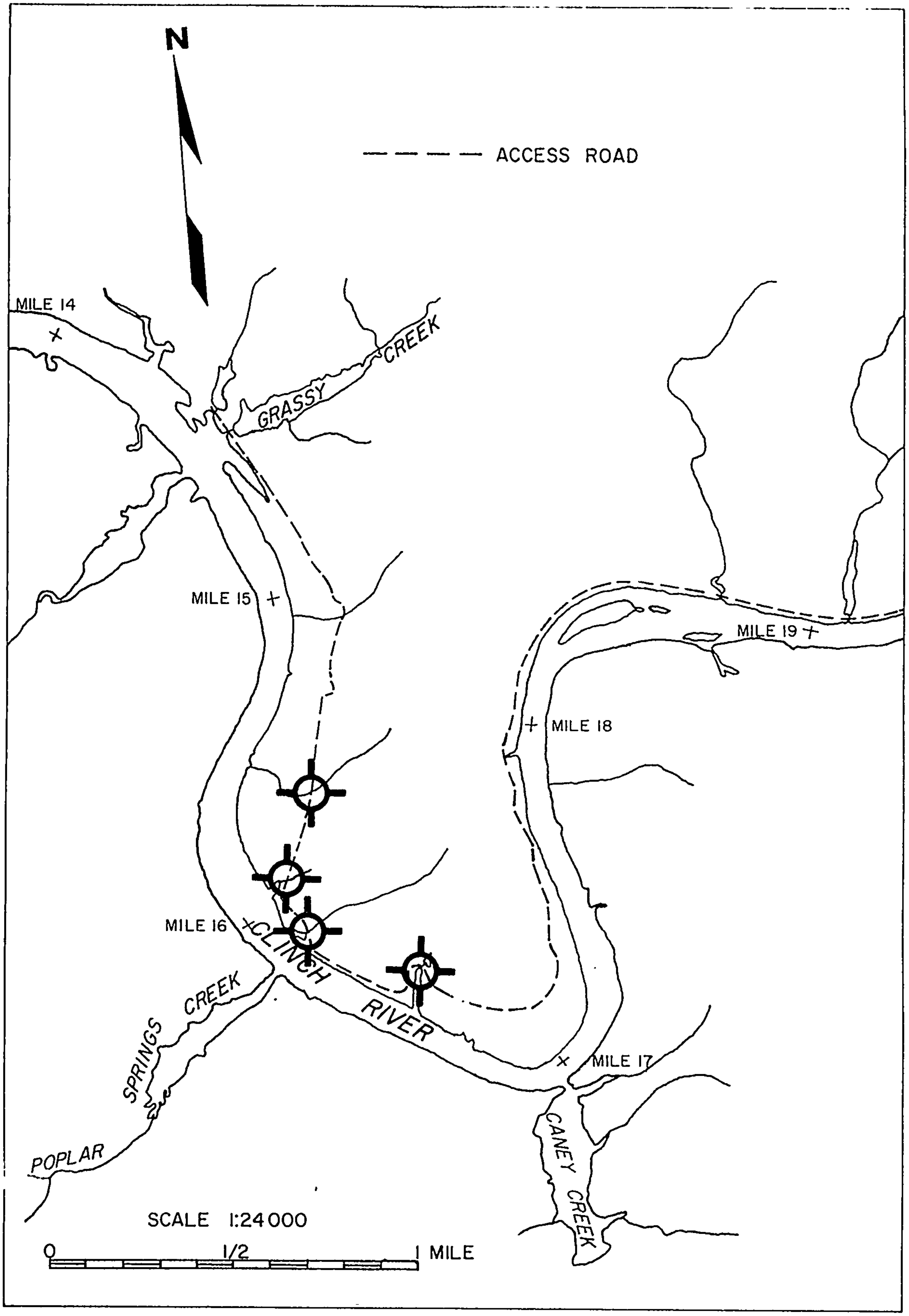


FIGURE III.3 PERIPHERAL SAMPLING STATIONS FOR SITE STORMWATER RUNOFF
CRBRP - (1976-1978)

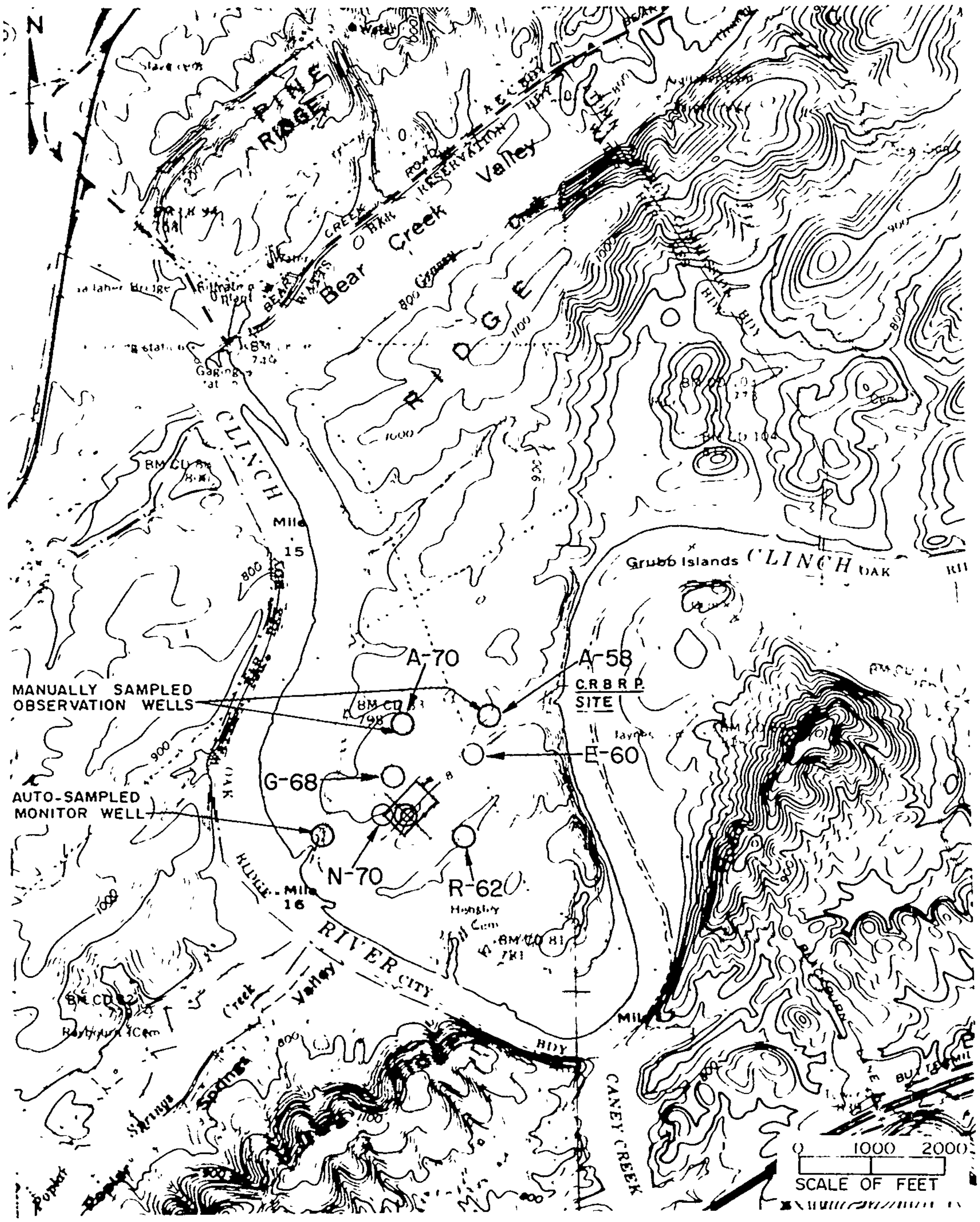


FIGURE III.4 LOCATION OF GROUND WATER OBSERVATION WELLS
CRBRP (1976-1977)

IV. River Substrate Characteristics

IV. River Substrate Characteristics

Introduction

With a knowledge of the substratum of a stream or river, one can often predict the composition of the invertebrate fauna that will be present. In general, the larger the stones, and hence the more complex the substratum, the more diverse is the invertebrate fauna (Hynes, 1970). Sand is a relative poor substrate, but silty sand is richer, and muddy substrata may support a large biomass although the diversity is reduced.

It is important to have a knowledge of the substrate to be able to effectively evaluate the macroinvertebrate fauna. Substrate classification permits the categorization of the various substrates. Pennak (1971) classified lotic habitats according to several factors one of which was dominant substrate. The categories he used were rubble and boulders, gravel, sand, organic or inorganic silt, coarse organic debris, and hardpan. Cummins and Lauf (1968) provide a description of substrate particle size terminology and categories that is a modification of the Wentworth classification system. The Wentworth classification included the following categories:

Name	Particle Size (mm)	Phi Scale
Boulder	7256	-8
Cobble	64-256	-6,-7
Pebble	32-64	-5
	16-32	-4
	8-16	-3
	4-8	-2
Granule	2-4	-1
Very Coarse Sand	1-2	0
Coarse Sand	0.5-1	1
Medium Sand	0.25-0.5	2
Fine Sand	0.125-0.25	3
Very Fine Sand	0.0625-0.125	4
Silt	0.0039-0.0625	5,6,7,8
Clay	<0.0039	9

Cummins modified the classification by including the granule and a portion of the pebble (8-16 and 4-8 mm) in a category called gravel. The Wentworth classification has been used in this report.

Field and Laboratory Methods

Sediment samples were collected monthly from March 1975 to October 1975, and seasonally during 1976 and 1977. One sediment sample was obtained at CRM 14.4, CRM 15.4, CRM 17.9, and CRM 19.0, using a Ponar grab sampler. The sample was stored on ice and returned to the laboratory where it was forzen until the sediment analysis could be done.

Sediment composition was determined by the methodology outlined in Quality Assurance Procedure No. WQEB-SS-2, Rev. 0 (TVA, 1978) and the data were recorded on the Phi (ϕ) scale. The methodology used in 1975, 1976, and 1977 was the same as in the above procedural document. The percentage composition of each sample by Phi size was determined by dividing the total sediment weight into the weight of the sediment for each individual Phi size. These values were then used in a clustering strategy known as UPGMA (unweighted pair-group method using mathematical averages) (Sneath and Sokal, 1973) to determine if the stations through time were similar. This procedure is termed a Q-mode analyses with the stations being OTU's (operational·taxonomic units) and the Phi particle sizes the characters (e.g., Clinch River mile 14.4 in April 1975 would be one OTU). The coefficient of similarity used in this cluster analysis was the product moment correlation coefficient.

Results

The results of the Phi particle analysis are tabulated in Tables IV.1, IV.2, and IV.3 for the years 1975, 1976, and 1977, respectively. These data are evaluated in the clustering dendogram (Figure IV.1). Different levels of correlation and groupings can be obtained by drawing lines across the dendogram at selected intervals. These lines were first termed "phenon lines" by Sneath and Sokal (1962) and the level of the line can be denoted by simply adding the correlation value as a prefix. The level of association chosen for differentiating the associations in this dendogram was the 0.520-phenon line.

The 0.520-phenon line defines six distinct clusters identified as A, B, C, D, E, and F. With the exception of clusters A, E, and F, each cluster was subdivided into at least two additional groupings.

Clinch River mile 14.4 and CRM 17.9 in 1975 were distinctly unique from any of the other stations, including CRM 14.4 and CRM 17.9 in 1976 and 1977. This is indicated by the low similarity of clusters E and F with the others. Cluster F includes the stations (OTU's) in which the majority of the sediment was cobble (greater than 50 percent). Cluster E contains those stations that were less than 50 percent cobble in their composition but were also composed of pebble sized sediments. Cluster A is unique in that it was the only station that was composed primarily of fine sand and silt. Cluster B is separated into those stations that included very coarse, coarse, and medium sand (cluster 1) and those stations that ranged from 50 to 86.8 percent medium sand in composition (cluster 2).

Table IV.1

Percent Composition of the Sediment Samples Collected

in the Vicinity of the Proposed CRBRP, Clinch River - 1975

CRM	Particle Size Ø	mm	Substrate	March	April	May	June	July	August	September	October
14.4	-6	64	Cobble	73.5	31.7	63.6	89.3	42.0	78.5	78.6	95.25
	-4	16	Pebble	5.2	37.2	36.5	9.6	29.4	17.7	5.5	4.75
	-2	4	Pebble	9.6	24.3	-	1.1	26.0	-	-	-
	-1.0	2	Granule	5.9	6.8	-	-	2.8	2.1	10.5	-
	0	1	Very coarse sand	4.5	-	-	-	-	1.8	5.5	-
	1	0.5	Coarse sand	1.5	-	-	-	-	-	-	-
15.4	-2	4	Pebble	25.1	0.0	31.8	23.4	25.9	19.9	13.4	22.1
	-1	2	Granule	16.5	0.37	14.6	16.8	16.5	13.4	9.4	22.4
	0	1	Very coarse sand	17.8	0.22	16.6	18.8	20.1	19.6	11.0	25.9
	1	0.5	Coarse sand	20.4	9.5	17.6	20.3	10.7	20.0	14.2	20.7
	2	0.25	Medium sand	11.8	86.8	11.3	13.1	19.4	12.1	50.4	7.8
	3	0.125	Fine sand	8.4	3.0	8.1	8.1	7.4	11.4	1.4	1.0
	4	0.0625	Very fine sand	0	0.05	0.0	0.0	0.1	2.2	0.2	0.1
	5	0.031	Coarse silt	0.1	0.06	0.1	0.1	0.1	1.7	0.1	0.1
17.9	-6	64	Cobble	67.6	-	95.7	88.7	-	-	29.8	61.95
	-4	16	Pebble	25.2	-	2.2	6.6	50.0	-	54.5	38.05
	-2	4	Pebble	-	16.8	2.1	-	50.0	23.6	13.0	-
	-1	2	Granule	7.1	13.4	-	2.9	-	16.2	2.8	-
	0	1	Very coarse sand	-	39.1	-	1.9	-	20.2	-	-
	1	0.5	Coarse sand	-	27.3	-	-	-	17.7	-	-
	2	0.25	Medium sand	-	3.3	-	-	-	13.7	-	-
	3	0.125	Fine sand	-	0.1	-	-	-	4.0	-	-
	4	0.0625	Very fine sand	-	0.0	-	-	-	2.8	-	-
	5	0.031	Coarse silt	-	0.2	-	-	-	2.0	-	-
19.0	-2	4	Pebble	22.8	12.0	22.0	20.7	27.4	19.8	16.0	17.6
	-1	2	Granule	36.5	27.3	37.1	22.1	15.7	15.9	20.8	14.1
	0	1	Very coarse sand	30.0	45.8	29.3	19.1	19.0	20.1	34.9	30.7
	1	0.5	Coarse sand	7.5	14.1	7.0	15.1	22.3	19.5	18.2	26.4
	2	0.25	Medium sand	1.9	0.3	3.0	9.7	15.2	13.7	6.1	9.1
	3	0.125	Fine sand	1.3	0.1	1.6	13.3	0.5	11.0	4.1	1.6
	4	0.0625	Very fine sand	0.0	0.05	0.0	0.05	0.05	0.05	0.0	0.15
	5	0.031	Coarse silt	0.1	0.5	0.1	0.1	0.05	0.1	0.1	0.5

- = Absence of a substrate type in the sediment sample.

Table IV.2

Percent Composition of the Sediment Samples Collected

in the Vicinity of the Proposed CRBRP, Clinch River - 1976

CRM	Particle Size Ø	Particle Size mm	Substrate	March 8	May 8	July 13	September 8
14.4	-6	64	Cobble	-	37.4	33.4	-
	-2	4	Pebble	14.6	61.7	64.7	99.9
	-1	2	Granule	38.0	0.2	1.1	0.1
	0	1	Very coarse sand	33.1	0.1	-	-
	1	0.5	Coarse sand	9.9	0.2	0.3	-
	2	0.25	Medium sand	3.7	0.2	0.4	-
	3	0.125	Fine sand	0.2	0.1	0.1	-
	4	0.0625	Very fine sand	0.1	-	-	-
	5	0.031	Coarse silt	0.1	0.2	-	0.05
15.4	-2	4	Pebble	-	31.5	28.2	0.05
	-1	2	Granule	-	24.4	31.1	0.1
	0	1	Very coarse sand	0.3	2.2	3.5	0.3
	1	0.5	Coarse sand	5.2	13.0	14.2	11.0
	2	0.25	Medium sand	87.0	26.8	21.9	85.1
	3	0.125	Fine sand	7.2	1.8	0.7	3.5
	4	0.0625	Very fine sand	0.2	0.3	0.3	0.1
	5	0.031	Coarse silt	0.1	0.2	0.1	-
17.9	-2	4	Pebble	17.8	42.3	49.9	99.9
	-1	2	Granule	40.1	38.3	40.6	0.04
	0	1	Very coarse sand	27.2	3.5	5.5	0.05
	1	0.5	Coarse sand	10.5	4.7	1.7	-
	2	0.25	Medium sand	3.9	10.5	1.9	-
	3	0.125	Fine sand	0.5	0.1	0.4	-
	4	0.0625	Very fine sand	0.05	0.1	0.02	-
	5	0.031	Coarse silt	0.05	0.1	0.02	-
19.0	-2	4	Pebble	25.3	57.7	52.6	50.3
	-1	2	Granule	37.8	14.2	40.5	25.2
	0	1	Very coarse sand	29.1	4.7	3.6	11.7
	1	0.5	Coarse sand	5.6	8.0	1.4	3.9
	2	0.25	Medium sand	2.2	14.5	1.7	6.1
	3	0.125	Fine sand	0.2	0.8	0.2	2.6
	4	0.0625	Fine sand	-	0.05	0.03	0.2
	5	0.031	Very fine sand	-	0.06	0.02	0.06

- = Absence of a substrate type in the sediment sample.

Table IV.3

Percent Composition of the Sediment Samples Collected

in the Vicinity of the Proposed CRBRP, Clinch River - 1977

CRM	Particle Size Ø	Particle Size mm	Substrate	March	May	July
14.4	-2	4	Pebble	73.2	6.4	4.0
	-1	2	Granule	2.5	6.1	0.90
	0	1	Very coarse sand	1.5	6.1	1.5
	1	0.50	Coarse sand	3.5	36.0	3.0
	2	0.25	Medium sand	17.0	43.1	4.5
	3	0.125	Fine sand	1.9	2.1	39.0
	4	0.0625	Very fine sand	0.10	0.25	23.3
	5	0.031	Silt	0.28	0.15	25.0
			Collodial number	0.02	0.20	1.2
15.4	-2	4	Pebble	12.5	39.1	26.0
	-1	2	Granule	41.9	11.4	20.0
	0	1	Very coarse sand	39.9	23.3	0.70
	1	0.50	Coarse sand	5.3	22.0	1.5
	2	0.25	Medium sand	0.29	4.1	43.1
	3	0.125	Fine sand	0.14	0.31	6.4
	4	0.0625	Very fine sand	0.0	0.06	0.80
	5	0.031	Silt	0.03	0.05	1.8
			Collodial number	0.06	0.32	0.30
17.9	-2	4	Pebble	11.7	30.0	75.9
	-1	2	Granule	15.1	36.0	2.1
	0	1	Very coarse sand	18.7	26.0	1.3
	1	0.50	Coarse sand	25.3	7.0	1.3
	2	0.25	Medium sand	28.4	1.6	1.9
	3	0.125	Fine sand	0.62	0.23	4.6
	4	0.0625	Very fine sand	0.04	0.03	3.3
	5	0.031	Silt	0.07	0.06	9.6
			Collodial number	0.07	0.92	0.0
19.0	-2	4	Pebble	9.0	60.0	66.3
	-1	2	Granule	9.4	19.4	2.7
	0	1	Very coarse sand	26.3	10.0	1.8
	1	0.50	Coarse sand	43.8	5.4	1.8
	2	0.25	Medium sand	13.5	4.8	5.4
	3	0.125	Fine sand	1.3	0.58	13.0
	4	0.0625	Very fine sand	0.08	0.07	3.1
	5	0.031	Silt	0.27	0.08	5.8
			Collodial number	3.7	0.33	0.10

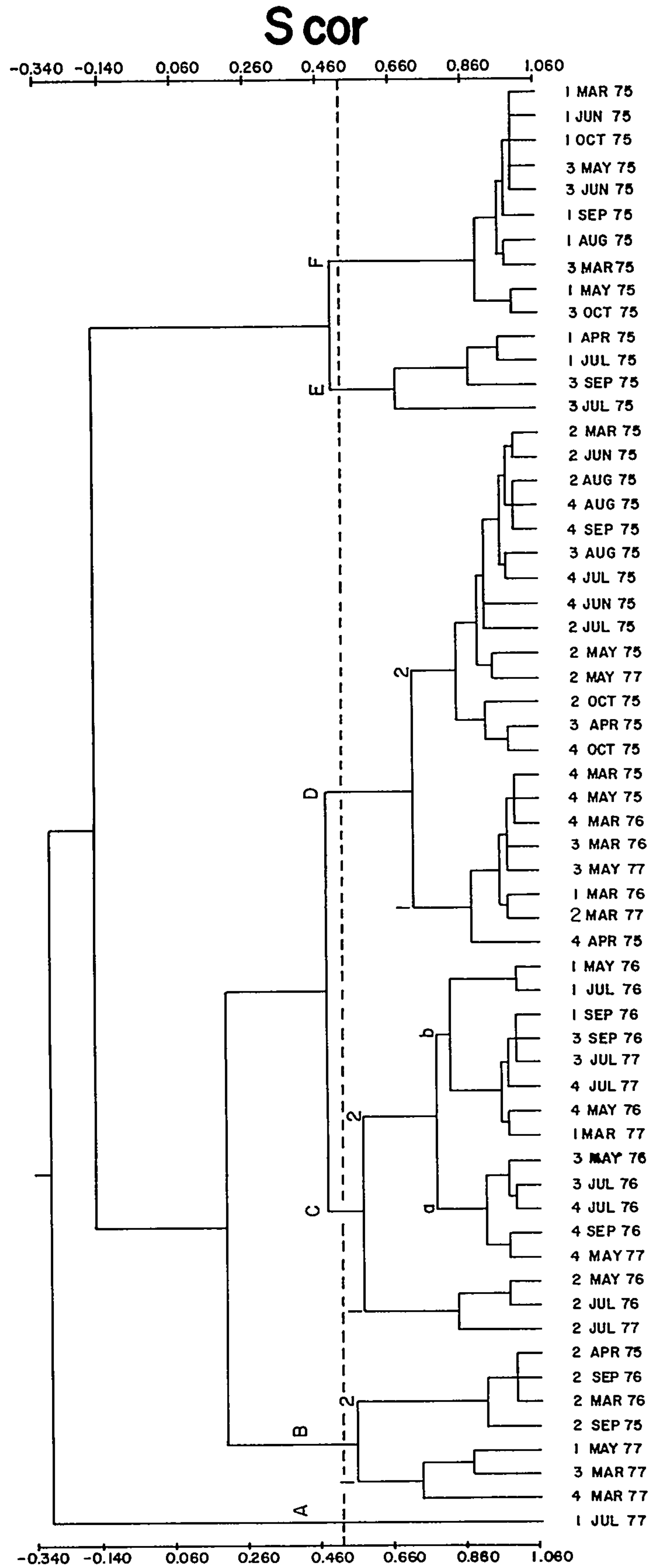


Figure IV.1. Dendogram of the Sediment Data prepared by the unweighted pair group method using arithmetic averages, UPGMA, clustering strategy; based on the product moment correlation coefficients. Abscissa is the magnitude of the correlation coefficient. The dashed line is the 0.520-phenon line. The column to the right indicates the station (CRM 14.4=1, CRM 15.4=2, CRM 17.9=3, CRM 19.0=4) and the time it was sampled.

Cluster C includes locations that were composed of sediments containing pebble and granule in a proportion greater than 46 percent and a greater than 21 percent composition of medium sand (cluster 1). Cluster 2 is divided into two groups on the following basis. Cluster a included stations that were 60-90 percent pebble. Cluster b was a mixture of stations in which sediment was a 60 percent or greater composition of pebble and granule.

Cluster D comprised two clusters, one that was composed of at least 40 percent pebble and granule-sized sediments, while the other (cluster 1) included stations with sediments that were of the following composition: pebble and granule (>50 percent), very coarse sand (>25 percent).

Discussion

The substrates at CRM 14.4 and CRM 17.9 were more similar to each other in 1975 as indicated by the clustering evaluation. This was primarily due to the substrate being of a cobble nature. River miles 15.4 and 19.0 in 1975 were similar to one another and are contained in the cluster sequence D-2. They were composed of sediments in the very coarse sand to pebble categories.

In 1976 and 1977 there is no distinct groupings of river miles such as were found in 1975. Even CRM 14.4 and CRM 17.0 were distinctly different from 1975 in 1976 and 1977. In 1976 and 1977 sampling stations were removed laterally to locations that contained sediments that were more easily sampled with a Ponar grab sampler. Pebble and cobble sized sediments prevent the closure of the sampler, thus making it difficult to obtain samples.

However, scuba divers reported that the area in the vicinity of the CRBRB was composed of hardpan with sediments of differing composition interspersed throughout the area. (Wade, personal communication).* The abundance of hardpan substrate could possibly account for the low diversity of benthic fauna. In general one would expect a more diverse fauna in the area based on sediment samples.

Conclusions

The substratum in the area of the CRBRP is predominantly coarse in nature with the majority of the sediment being classified as rocky.

The sediments collected in 1975 indicated a similarity between CRM 14.4 and CRM 17.9. They also indicated a similarity between CRM 15.4 and 19.0. However, in 1976 and 1977 the similarily between these stations was not as definable and is attributed to the collection of sediment samples at different locations.

The presence of considerable amounts of hardpan in the area may account for the low diversity of benthic fauna.

*Donald Wade, Biologist, TVA.

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V. Clinch River Water Quality

V. Clinch River Water Quality

Introduction

As discussed in Chapter II, the water quality of the Clinch River in the site vicinity is influenced by several factors, primarily releases from Melton Hill Dam, river morphology, regional geology, ground water baseflow, land use practices, and waste discharges.

The evaluation of the water quality of the Clinch River in the site vicinity is based primarily on data obtained by the sampling of three stations. In addition, samples were collected at the Melton Hill Dam tailrace as part of an existing TVA regional water quality management monitoring network. Water quality data collected by the Tennessee Divison of Water Quality Control at CRM 10.0 as part of their monitoring network is also reported in this chapter. A review of these data is presented.

Field and Laboratory Methods

All water quality samples were collected, samples handled, and field analyses performed in conformance with the Water Quality and Ecology Branch "Standard Methods for Routine Water Quality and Aquatic Biological Field Surveys," WQEB-SS-1, dated June 1, 1978, (replaced "Handbook of Standard Procedures for the Collection of Water Samples," I-WQ-74-1, dated February 1974). The analytical and sample preservation methods used for each water quality parameter is described in Appendix D. All data utilized in the evaluation of the Clinch River in the site vicinity has been entered into EPA's STORET system. Individual copies of the data are available upon request to the TVA Water Quality and Ecology Branch to those who do not have access to STORET.

Results

Temperature

Due to releases from Melton Hill Dam just upstream of the site and river morphology, the Clinch River in the site vicinity is well mixed thermally in the vertical direction. The monthly means of the observed temperature gradients along with corresponding mean temperatures and extremes are summarized in Table V.1. An evaluation of the temperature data obtained during the monitoring period shows that a maximum vertical thermal gradient of 3.4°C was measured at CRM 14.4 on April 12, 1977, when hourly flows ranged from 320 cms (11,300 cfs) to 326 cms (11,500 cfs). Vertical thermal gradients greater than 1°C were observed when flow conditions ranged from 0 cms to 297 cms (10,500 cfs) during the months of March, April, June, July, and August. Normally thermal gradients were below 1.0°C with 73 percent of the vertical profile measurements having a thermal gradient of less than 0.5°C (CRM 14.4--63 percent, CRM 15.4--77 percent, CRM 17.9--77 percent, CRM 19.0--87 percent).

The occurrence of larger thermal gradients was greatest at CRM 14.4. This may be due to point source thermal discharges into Poplar Creek (CRM 12.0). During periods of reversed river flow the heated surface layer from the creek entering the river will flow upstream, thus elevating river surface temperatures in the vicinity of the confluence of the river and the creek.

Table V.1

Observed Temperatures and Mean Vertical Thermal Gradients in the Clinch River in the Vicinity of the CRBRP, 1975 through 1977
(°C)

Month	Maximum	Mean	Minimum	Standard Deviation	Number of Observations	Mean Gradient
January	10.0	6.5	3.0	1.64	31	0.0
February*	12.0	8.2	4.5	2.37	10	-
March	15.6	9.9	7.8	1.68	71	0.2
April	15.6	12.3	10.0	1.70	68	0.4
May	17.5	16.0	10.0	1.41	70	0.1
June	20.8	18.2	16.0	1.34	95	0.5
July	21.5	18.1	15.6	1.93	100	0.6
August	24.0	18.8	17.0	1.12	82	0.4
September	23.0	19.9	17.8	0.76	97	0.2
October	20.6	18.2	12.0	1.20	98	0.1
November*	17.2	13.7	8.3	2.72	14	-
December*	12.0	9.7	7.0	1.54	13	-

*Data collected at Melton Hill Dam tailrace at the water surface only. All other reported extremes were observed at various depths.

Further evaluation of the temperature data obtained during the monitoring period shows that temperatures were well below the Tennessee standard of 30.5°C. The maximum observed temperature was 24°C, which occurred at Melton Hill Dam tailrace (CRM 23.1) in August 1977. This measurement was at the water surface. The maximum observed temperature at 1.5 m was 21°C, which occurred at CRM 14.4 on July 15, 1976, (130 cms [4,600 cfs]). Figures V.1 through V.3 show the temperature levels, as well as dissolved oxygen concentrations, in water passing through Melton Hill Dam during the period 1975 through 1977.

Figure V.4 depicts the monthly temperature levels observed during the montoring period. This is a seasonal representation showing changes in temperatures at a depth of 1.5 m. In this figure the levels reported for

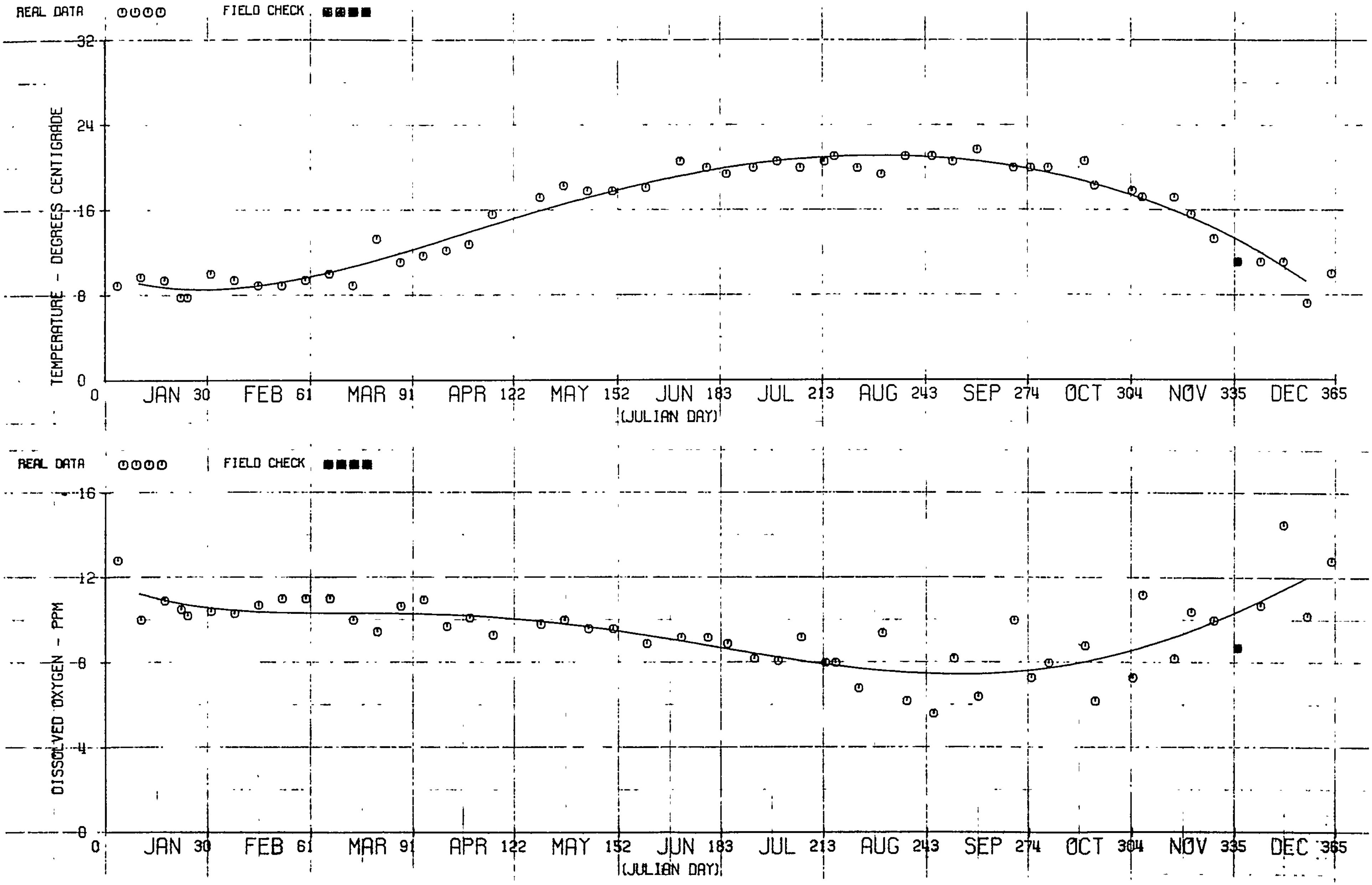

FIGURE V.1 TEMPERATURE LEVELS AND CONCENTRATIONS OF DISSOLVED OXYGEN IN WATER PASSING THROUGH MELTON HILL DAM IN 1975

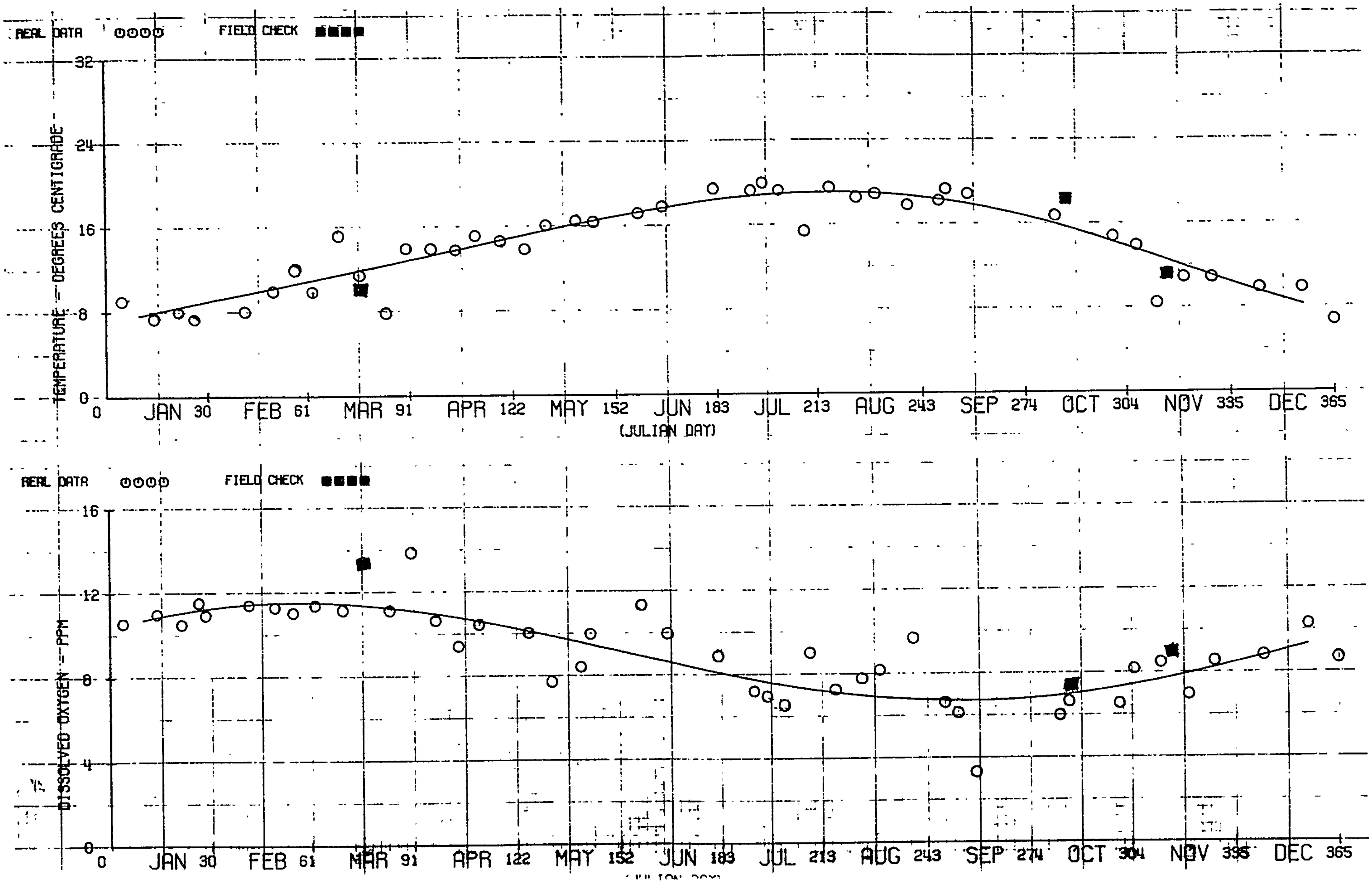

FIGURE V.2 TEMPERATURE LEVELS AND CONCENTRATIONS OF DISSOLVED OXYGEN IN WATER PASSING THROUGH MELTON HILL DAM IN 1976

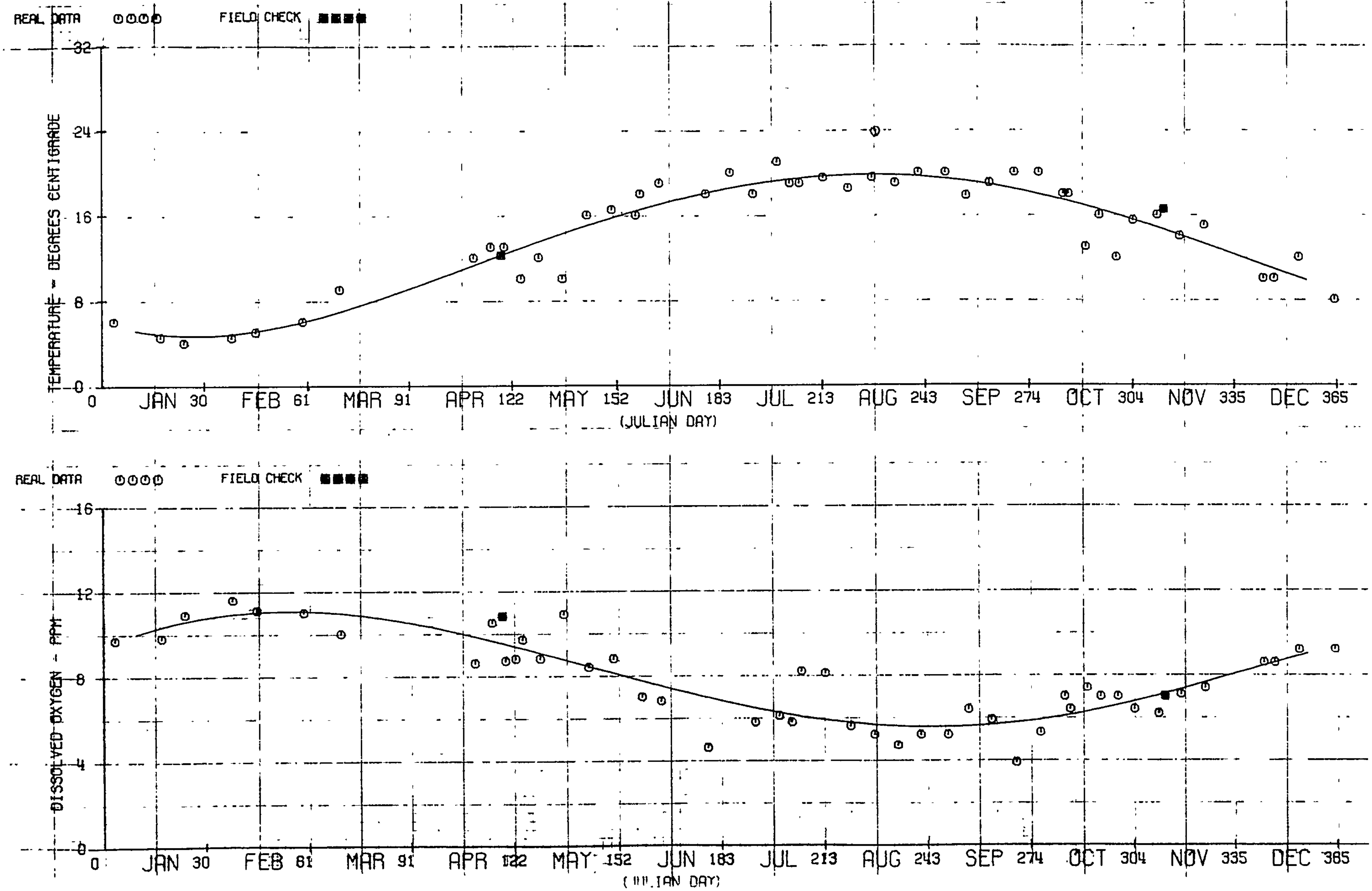

FIGURE V.3 TEMPERATURE LEVELS AND CONCENTRATIONS OF DISSOLVED OXYGEN IN WATER PASSING THROUGH MELTON HILL DAM IN 1977

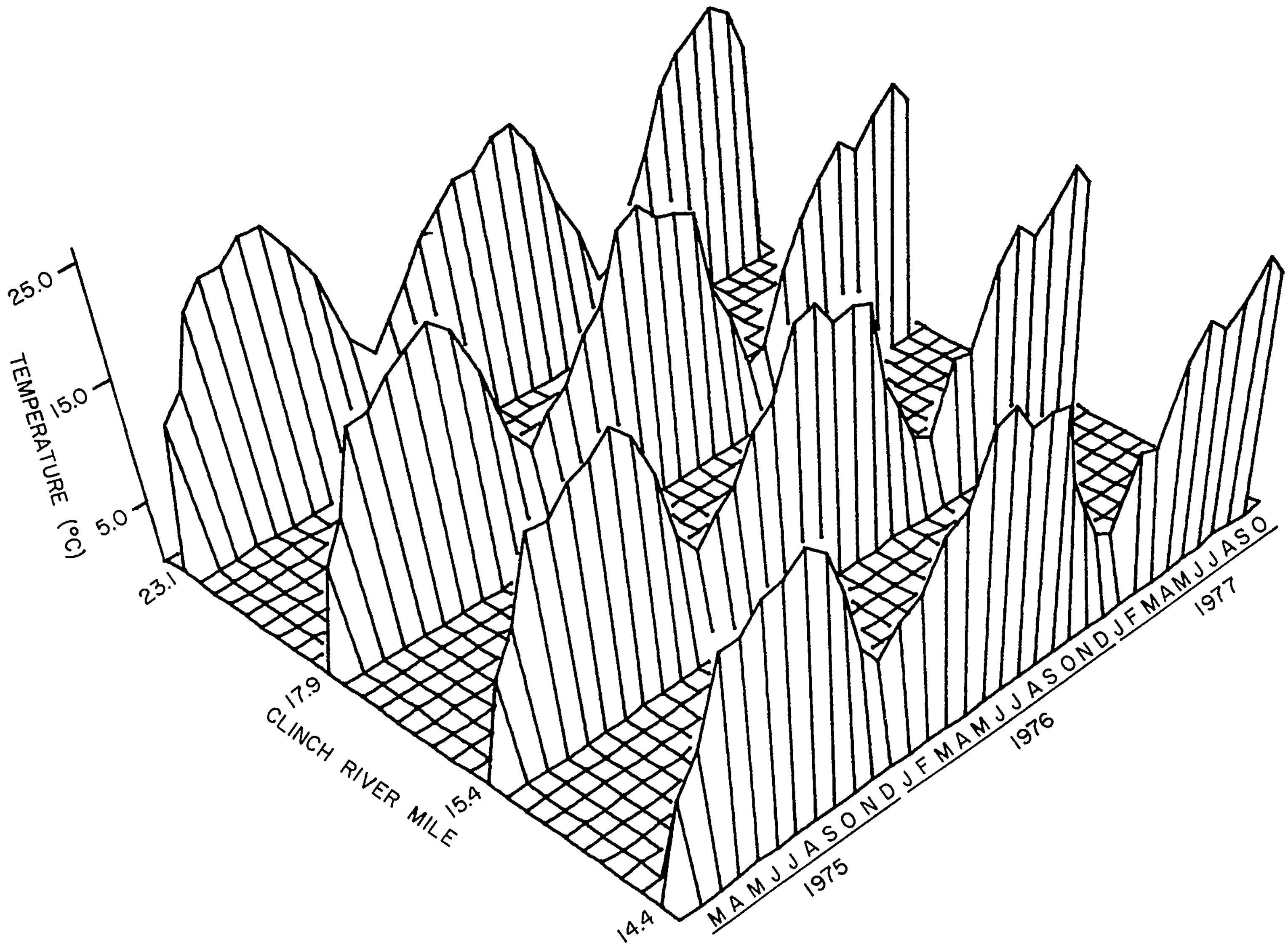

FIGURE V.4

CHANGES IN MONTHLY WATER TEMPERATURE OF THE CLINCH RIVER AT A DEPTH OF 1.5M, CRBRP - MARCH 1975 - OCTOBER 1977

Melton Hill Dam represent the monthly median value observed in samples from the water surface.

During the period June 1977 through October 1977 the temperature monitoring activity was expanded to include profile measurements at the left and right bank areas (5 percent and 95 percent, respectively, from the left bank facing the downstream direction). The highest temperatures (up to 23°C) and greatest vertical thermal gradients (up to 3.0°C) were observed on the right bank.

Dissolved Oxygen

The State of Tennessee water quality criterion for dissolved oxygen specifies that the concentration shall not be less than 5.0 mg/l at a depth of 1.5 m (5 ft) or mid-depth, whichever is less. Exceptions may be granted in a limited section of a stream due to natural qualities of the water, cost of meeting standards compared to benefits, and treatment technology, but in no instance can the DO concentration be less than 3.0 mg/l.

The dissolved oxygen environment of the Clinch River in the site vicinity was well mixed in the vertical direction. The monthly averages of the observed dissolved oxygen vertical gradients along with corresponding mean temperatures and extremes are summarized in Table V.2. An evaluation of the dissolved oxygen data obtained during the monitoring period shows that a maximum dissolved oxygen vertical gradient of 1.4 mg/l was measured at CRM 17.9 on July 13, 1977, (375 cms [13,250 cfs]). Vertical gradients greater than 1.0 mg/l were also observed at CRM 14.4 and CRM 15.4. Normally dissolved oxygen gradients were well below 1.0 mg/l with 70 percent of the vertical profile measurements having a gradient of less than 0.5 mg/l (CRM 14.4--72 percent, CRM 15.4--68 percent, CRM 17.9--68 percent, CRM 19.0--75 percent).

Table V.2

Observed Concentrations of Dissolved Oxygen and Mean Vertical Dissolved Oxygen Gradients in the Clinch River in the Vicinity of the CRBRP 1975 through 1977 (mg/l)

Month	Maximum	Mean	Minimum	Standard Deviation	Number of Observations	Mean Gradient
January	12.2	11.5	9.7	0.86	32	0.2
February*	11.6	11.0	10.3	0.38	10	-
March	13.9	11.3	9.4	0.61	67	0.2
April	10.9	9.8	8.6	0.59	67	0.3
May	11.3	9.9	7.8	0.60	70	0.3
June	10.0	8.6	4.6	1.09	91	0.4
July	9.2	7.0	5.5	0.76	97	0.8
August	9.6	7.3	4.7	0.62	94	0.1
September	10.0	6.8	3.2	1.38	94	0.1
October	8.5	7.1	5.3	0.49	98	0.4
November*	11.2	8.4	6.2	1.48	13	-
December*	12.8	10.0	8.6	1.88	12	-

*Data collected at Melton Hill Dam tailrace at the water surface only. All other reported extremes were observed at various depths.

During the monitoring period, concentrations of dissolved oxygen were good being equal to or greater than 5.0 mg/l at all river stations. The lowest concentration observed at 1.5 m (5 ft) was 5.0 mg/l at CRM's 15.4 and 14.4 on September 16, 1975, when there was no discharge from Melton Hill Dam.

Figure V.1 through Figure V.3 show the concentration of dissolved oxygen, as well as temperature levels, in the water passing through Melton Hill Dam during the period 1975 through 1977. On September 20, 1976, June 27, 1977, August 22, 1977, and September 26, 1977, concentrations below 5.0 mg/l, were measured at Melton Hill Dam tailrace (3.2 mg/l, 4.6 mg/l, 4.7 mg/l, and 3.9 mg/l, respectively). It appears that there is sufficient reaeration capacity between the dam (CRM 23.1) and CRM 17.9 to increase low dissolved oxygen levels to 5.0 mg/l.

Figure V.5 depicts the monthly concentrations of dissolved oxygen observed during the monitoring period. This is a seasonal representation showing changes in the concentration at a depth of 1.5 m. In this figure, the concentrations reported for Melton Hill Dam represent the monthly median value observed in samples from the water surface.

Further evaluation of the dissolved oxygen data obtained during the monitoring shows that dissolved oxygen saturation ranged from 56 to 111 percent. The minimum saturation level occurred during surveys performed in September 1975 (CRM's 17.9 and 19.0) and in July 1977 (CRM 14.4). The maximum saturation level occurred during surveys performed in May 1977 (CRM 15.4). Saturation levels between 105 and 109 percent occurred during surveys conducted in May 1975 (CRM's 14.4, 15.4, 17.9, and 19.0), March 1976 (CRM 23.1), March 1977 (CRM's 14.4, 15.4, and 17.9), and June 1977 (CRM 15.4). During the surveys conducted in September 1975 and March 1977 there were no releases from Melton Hill Dam.

During the period June 1977 through October 1977 the dissolved oxygen monitoring activity was also expanded to include profile measurements at the left and right bank areas. Dissolved oxygen concentrations, saturation levels, and vertical gradients at the river bank stations were normally equal to or less than those observed at midstream.

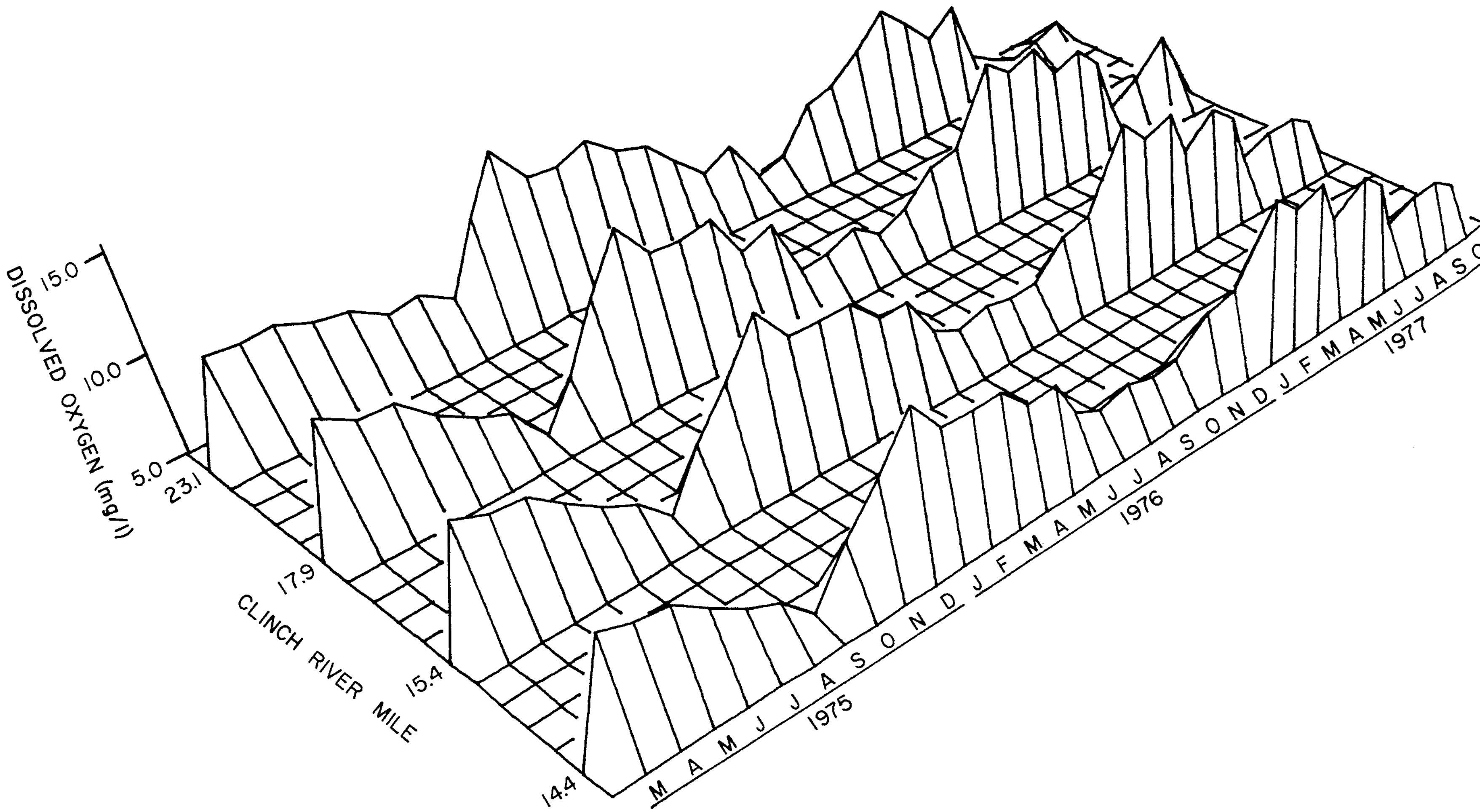

FIGURE V.5 CHANGES IN MONTHLY CONCENTRATION OF DISSOLVED OXYGEN IN THE CLINCH RIVER AT A DEPTH OF 1.5m

CRBRP - MARCH 1975 - OCTOBER 1977

Other Constituents

Listed in Table V.3 are summaries of the remaining physical, nutrient, metal, and sanitary-chemical data for the Clinch River in the site vicinity. Each water quality group is discussed below.

Physical Constituents Other than Temperature and Dissolved Oxygen

As shown in Table V.3 observed pH values ranged from 6.5 to 8.5 S.U., which is considered the normal range necessary to support biological communities and is the Tennessee pH criterion for waters used for the propagation and maintenance of fish and aquatic life. The river water has a high buffering capacity with total alkalinity averaging 87 mg/l. Bicarbonate alkalinity is the predominate form of alkalinity.

Turbidity and concentrations of suspended solids were normally low except after periods of heavy rainfall, with values ranging from 1.1 to 55 NTU and 1.0 to 51 mg/l, respectively. True color levels also followed this trend ranging from 1 to 20 P.C.U. Turbidity, suspended solids, and color levels increased in the downstream direction reflecting the quality of water from small creeks and drainageways entering the river between CRM's 23.1 and 14.4 (refer to Chapter VI).

Conductivity levels and concentrations of dissolved solids were low averaging 220 umhos and 125 mg/l, respectively.

Nutrients

As shown in Table V.3, nutrients measured were nitrogen, phosphorus, potassium, sodium, calcium, magnesium, and silica. Concentrations of nitrogen in the forms of ammonia, organic, and nitrate plus nitrite varied widely during the monitoring period. Unionized ammonia concentrations, which is the most toxic form, were well below 0.02 mg/l. Organic nitrogen

TABLE V.3

SUMMARY OF WATER QUALITY DATA FROM THE CLINCH RIVER IN THE VICINITY OF THE CRBRP, MARCH 1975 THROUGH OCTOBER 1977

Parameter	CRM 23.1 Observed Concentrations Maximum	CRM 23.1 Minimum	CRM 23.1 Mean	CRM 23.1 Standard Deviation	CRM 23.1 No. of Samples	CRM 19.0 Observed Concentrations Maximum	CRM 19.0 Minimum	CRM 19.0 Mean	CRM 19.0 Standard Deviation	CRM 19.0 No. of Samples
Alkalinity (total as $CaCO_3$), mg/l	120	76	96	9.70	36	110	3.0	78	33.0	26
Aluminum, μg/l	1200	60	420	361	12					
Ammonia nitrogen, mg/l	0.14	<0.01	0.05	0.03	35	0.05	0.01	0.02	0.01	27
Arsenic, μg/l	6.0	<2.0	<5.0	1.16	8					
Barium, μg/l	<100	<100	<100	0.0	11					
Beryllium, μg/l	<10	<10	<10	0.0	11					
Biochemical oxygen demand (5-day), mg/l	2.6	<1.0	<1.4	0.8	4	<1.0	<1.0	<1.0	0.0	27
Boron, μg/l	680	40	180	223	7					
Cadmium, μg/l	3.0	<1.0	<1.0	0.60	13	1.0	<1.0	<1.0	0.0	26
Calcium, mg/l	37	20	30	3.70	30	30	20	26	3.32	26
Chemical oxygen demand, mg/l	25	2.0	6.0	3.91	34	14	<1.0	4.0	3.02	27
Chloride, mg/l	6.0	1.0	4.0	1.10	30	3.0	2.0	3.0	0.36	27
Chromium, mg/l	10	<5.0	<5.0	1.67	9	<5.0	<5.0	<5.0	0.0	26
Coliform (total), no./100 ml						1650	<10	770	3366	24
Coliform (fecal), no./100 ml	10	<10	<10	0.0	4	100	<10	<20	30.4	24
Color (true), PCU	17	1.0	6.0	4.28	34	19	3.0	10	4.36	27
Color, (apparent), PCU	40	5.0	19	10.5	33	38	10	20	7.52	27
Conductivity, μmhos	280	170	230	23.1	36	240	150	21	21.7	43
Copper, μg/l	70	<10	30	19.6	13	110	<10	34	30.1	26
Fluoride, mg/l	<0.1	<0.1	<0.1	0.0	25					
Hardness (as $CaCO_3$), mg/l	140	78	109	14.5	29	110	77	95	10.1	26
Iron (total), μg/l	1000	130	360	229	33	460	70	260	115	26
Iron (dissolved), μg/l	<50	-	-	-	1	50	50	50	0.0	27
Iron (ferrous), μg/l	60	-	-	-	1	80	<20	40	13.9	27
Lead, μg/l	33	<10	<13	7.46	13	36	<10	<12	5.92	26
Lithium, μg/l	10	<10	<10	0.0	11					
Magnesium, mg/l	15	3.4	8.2	1.94	30	8.6	6.6	7.4	0.70	26
Manganese (total), μg/l	130	10	50	23.9	33	80	<10	36	13.4	23
Manganese (dissolved), μg/l	<10	-	-	-	1	10	<10	<10	0.0	24
Mercury, μg/l	1.0	<0.2	<0.3	0.22	13	0.3	<0.2	<0.2	0.19	27
Nickel, μg/l	<50	<50	<50	0.0	13	<50	<50	<50	0.0	26
Nitrate plus nitrite nitrogen, mg/l	1.3	0.1	0.5	0.24	32	0.59	0.21	0.46	0.11	27
Organic carbon (dissolved), mg/l	1.7	-	-	-	1	2.1	<0.2	1.0	0.53	23
Organic carbon (total), mg/l	4.7	1.4	2.5	1.01	13	3.4	1.0	1.6	0.57	27
Organic nitrogen, mg/l	0.84	0.02	0.14	0.14	35	0.26	0.03	0.10	0.06	27
pH, SU	8.2	7.0	7.7	0.31	37	8.1	7.3	7.7	0.28	43
Phosphorous (total), mg/l	0.06	0.01	0.02	0.01	32	0.03	<0.01	0.01	0.01	27
Phosphorous (dissolved), mg/l	0.01	<0.01	0.01	0.0	3	0.01	<0.01	<0.01	0.0	27
Potassium, mg/l	1.8	1.0	1.3	0.22	30	1.6	0.9	1.2	0.16	26
Residue (dissolved), mg/l	180	10	130	27.5	30	130	100	120	8.47	27
Residue (suspended), mg/l	18	1.0	6.0	4.77	31	11	1.0	6.0	2.75	27
Selenium, μg/l	<2.0	<1.0	<2.0	0.52	8					
Silica (dissolved), mg/l	6.8	1.7	4.1	1.35	24	6.0	3.9	5.0	0.65	27
Silver, μg/l	<10	<10	<10	0.0	11					
Sodium, mg/l	32	2.2	4.9	5.53	30	7.0	1.8	3.6	1.92	26
Sulfate, mg/l	23	4.0	16	4.40	30	18	9.0	14	2.57	27
Titanium, μg/l	<1000	<1000	<1000	0.0	11	18				1
Turbidity, JTU	19	1.1	7.1	4.71	35	13	1.3	4.9	2.63	27
Zinc, μg/l	90	<10	20	24.3	13	50	<10	20	11.1	26

TABLE V.3

(Continued)

Parameter	CRM 17.9 Observed Concentrations Maximum	Minimum	Mean	Standard Deviation	No. of Samples	CRM 15.4 Observed Concentrations Maximum	Minimum	Mean	Standard Deviation	No. of Samples
Alkalinity (total as $CaCO_3$), mg/l	100	4.0	87	16.3	107	110	5.0	87	16.8	101
Aluminum, µg/l										
Ammonia nitrogen, mg/l	0.23	<0.01	0.04	0.04	79	0.12	<0.01	0.02	0.02	74
Arsenic, µg/l										
Barium, µg/l										
Beryllium, µg/l										
Biochemical oxygen demand (5-day), mg/l	1.3	<1.0	<1.0	0.08	60	1.3	<1.0	<1.0	0.07	37
Boron, µg/l										
Cadmium, µg/l	1.0	<1.0	<1.0	0.0	49	2.0	<1.0	<1.0	0.19	28
Calcium, mg/l	35	20	29	3.82	49	33	20	27	3.76	28
Chemical oxygen demand, mg/l	12	<1.0	<4.0	2.23	79	8.0	<1.0	4.0	1.70	73
Chloride, mg/l	40	2.0	3.0	0.63	52	4.0	2.0	3.0	0.48	30
Chromium, mg/l	27	<5.0	<6.0	3.22	49	<5.0	<5.0	<5.0	0.0	28
Coliform (total), no./100 ml	1800	<10	190	478	23	2000	<10	160	452	21
Coliform (fecal), no./100 ml	190	<10	<30	41.3	30	100	<10	<20	32.3	21
Color (true), PCU	15	1.0	6.0	3.47	79	17	1.0	6.0	3.53	74
Color, (apparent), PCU	100	5.0	19	15.6	79	75	6.0	19	12.9	74
Conductivity, µmhos	270	100	220	45.1	183	270	100	220	46.3	176
Copper, µg/l	170	<10	36	36.0	49	110	<10	40	33.2	28
Fluoride, mg/l										
Hardness (as $CaCO_3$), mg/l	120	77	103	12.4	49	120	77	99	12.5	28
Iron (total), µg/l	6500	80	530	945	49	560	10	270	137	28
Iron (dissolved), µg/l	70	<50	50	3.79	46	160	<50	<60	23.1	25
Iron (ferrous), µg/l	360	<20	64	67.8	26	100	<20	50	20.8	24
Lead, µg/l	35	<10	<11	4.42	49	24	<10	<11	4.09	28
Lithium, µg/l										
Magnesium, mg/l	9.4	6.6	7.7	0.84	49	8.8	6.5	7.6	0.86	28
Manganese (total), µg/l	180	<50	55	29.6	46	50	10	30	10.4	25
Manganese (dissolved), µg/l	20	<10	<10	1.52	43	40	<10	10	6.64	22
Mercury, µg/l	0.5	<0.2	<0.2	0.05	46	1.7	<0.2	<0.3	0.30	25
Nickel, µg/l	60	<50	<50	1.43	49	<50	<50	<50	0.0	28
Nitrate plus nitrite nitrogen, mg/l	1.4	0.15	0.45	0.17	79	0.64	0.16	0.42	0.12	74
Organic carbon (dissolved), mg/l	2.3	<0.2	1.0	0.53	26	9.5	0.2	1.5	1.76	25
Organic carbon (total), mg/l	4.0	0.08	1.6	0.53	76	12	0.2	2.0	1.46	71
Organic nitrogen, mg/l	0.32	0.01	0.10	0.48	79	0.32	0.04	0.10	0.05	74
pH, SU	8.2	6.7	7.6	0.33	183	8.2	6.8	7.6	0.33	177
Phosphorous (total), mg/l	0.04	<0.01	0.02	0.01	78	0.05	<0.01	0.02	0.01	73
Phosphorous (dissolved), mg/l	0.04	<0.01	<0.01	0.01	67	1.0	<0.01	<0.05	0.21	67
Potassium, mg/l	1.7	0.09	1.26	0.18	49	1.5	0.9	1.2		26
Residue (dissolved), mg/l	150	70	125	12.6	79	240	80	125	18.9	74
Residue (suspended), mg/l	40	1.0	7.0	6.73	79	46	<1.0	9.0	8.55	74
Selenium, µg/l										
Silica (dissolved), mg/l	6.0	1.6	4.3	1.03	52	6.0	2.3	4.5	1.06	31
Silver, µg/l										
Sodium, mg/l	7.0	1.8	3.3	1.49	48	6.9	1.9	3.5	1.72	28
Sulfate, mg/l	27	10	16	3.49	52	21	9.0	15	2.97	31
Titanium, µg/l										
Turbidity, JTU	45	1.4	7.2	8.5	79	50	1.6	7.8	9.60	74
Zinc, µg/l	570	<10	36	81.7	49	130	<10	30	31.0	28

TABLE V.3
(Continued)

CRM 14.4

Parameter	Observed Concentrations: Maximum	Minimum	Mean	Standard Deviation	No. of Samples	EPA Water Quality Criteria[1]: Domestic Water Supply	Freshwater Aquatic Life
Alkalinity (total as $CaCO_3$), mg/l	140	9.0	88	17.3	101		
Aluminum, µg/l							<20
Ammonia nitrogen, mg/l	0.36	<0.01	0.03	0.42	75		0.13-51**
Arsenic, µg/l						50*	
Barium, µg/l						1000*	
Beryllium, µg/l							11
Biochemical oxygen demand (5-day), mg/l	2.0	<1.0	<1.1	0.17	56		
Boron, µg/l							
Cadmium, µg/l	2.0	<1.0	<1.0	0.21	46	10*	4
Calcium, mg/l	34	19	28	3.91	46		
Chemical oxygen demand, mg/l	12	<1.0	4.2	2.40	72		
Chloride, mg/l	4.0	2.0	3.0	0.65	50	250	
Chromium, mg/l	12	<5.0	<6.0	1.82	46	50*	100
Coliform (total), no./100 ml	7600	<10	<840	2075	21		
Coliform (fecal), no./100 ml	160	<10	<30	42.9	28		
Color (true), PCU	20	1.0	6.5	3.86	75	15	
Color, (apparent), PCU	100	5.0	20	14.9	75		
Conductivity, µmhos	270	100	220	44.4	175		
Copper, µg/l	170	<10	30	35.2	46	1000	
Fluoride, mg/l						1.4-2.4*	
Hardness (as $CaCO_3$), mg/l	120	75	103	12.9	46		
Iron (total), µg/l	2400	50	490	578	46	300	1000
Iron (dissolved), µg/l	280	<50	<60	39.4	43		
Iron (ferrous), µg/l	220	20	70	49.5	25		
Lead, µg/l	45	<10	<12	6.38	46	50*	
Lithium, µg/l							
Magnesium, mg/l	9.4	5.6	7.6	0.95	46		
Manganese (total), µg/l	140	<10	50	25.3	43	50	
Manganese (dissolved), µg/l	60	<10	<10	9.33	40		
Mercury, µg/l	2.5	<0.2	<0.2	0.35	43	2*	
Nickel, µg/l	90	<50	50	9.05	46		
Nitrate plus nitrite nitrogen, mg/l	0.95	0.17	0.43	0.14	75	10(NO_3)*	
Organic carbon (dissolved), mg/l	1.9	0.2	1.0	0.45	26		
Organic carbon (total), mg/l	5.2	0.9	1.8	0.69	72		
Organic nitrogen, mg/l	0.20	<0.01	0.10	0.03	75		
pH, SU	8.5	6.5	7.6	0.31	177	6.5-8.5	6.5-9.0
Phosphorous (total), mg/l	0.06	<0.01	0.02	0.01	75		
Phosphorous (dissolved), mg/l	0.02	<0.01	<0.01	0.01	65		
Potassium, mg/l	1.7	0.9	1.3	0.17	46		
Residue (dissolved), mg/l	230	90	125	17.9	75	500	
Residue (suspended), mg/l	51	1.0	9.0	9.48	75		
Selenium, µg/l						10*	
Silica (dissolved), mg/l	6.2	1.5	4.2	1.06	50		
Silver, µg/l						50*	
Sodium, mg/l	6.9	2.0	3.2	1.39	46		
Sulfate, mg/l	22	7.0	15	3.77	50	250	
Titanium, µg/l							
Turbidity, JTU	55	1.5	8.1	10.1	75	5*	
Zinc, µg/l	1900	<10	70	277	46	5000	

Primary [illegible] standard,[2] those not marked are secondary (aesthetically undesirable) standard[3]
Concentrations [illegible] ammonia (NH_3 + NH_4^+) which contain an unionized ammonia concentration of 0.02 mg/l
NH_3 [illegible] pH and temperature

concentrations were low, averaging 0.10 mg/l. At CRM's 23.1 and 17.9, concentrations of nitrate plus nitrite nitrogen of 1.3 mg/l and 1.4 mg/l, respectively, were measured. All other observations were below 1.0 mg/l. Total and dissolved phosphorus concentrations were normally low, averaging 0.02 mg/l and <0.01 mg/l, respectively.

Concentrations of potassium, sodium, calcium, magnesium, and silica were not excessive. The water is considered to be moderately hard.

Metals

As shown in Table V.3, except for mercury the concentrations of analyzed primary (health) constituents were less than those concentrations identified by EPA[2] for finished drinking water. On July 15, 1976, at CRM 14.4 at a depth of 4.9 m (16 ft) a mercury concentration of 2.5 ug/l was reported. Normally mercury concentrations were below the detectable limit of 0.2 ug/l.

Except for iron and manganese, the concentrations of analyzed secondary (aesthetically undesirable) constituents were less than those concentrations identified by EPA[3] for finished drinking water. Concentrations of iron and manganese ranged from 0.01 mg/l to 6.5 mg/l and <0.01 mg/l to 0.18 mg/l, respectively, and averaged 0.43 mg/l and 0.047 mg/l, respectively.

Sanitary-Chemical

The sanitary-chemical quality of the Clinch River was generally good. As shown in Table V.3, BOD, COD, TOC, and SOC concentrations were normally low. A COD concentration of 25 mg/l was observed at Melton Hill Dam tail-race in May 1976. COD concentrations were normally below 5 mg/l.

Total and fecal coliform densities ranged from <10 to 7,600 per ml and <10 to 190 per ml, respectively. High total coliform and elevated fecal coliform densities were observed on September 16, 1975. On this date, 0.25 cm (1 in.) of rainfall was recorded at Melton Hill Dam. The high nonfecal ratio would indicate that the source of the bacteria is soil and vegetation.

Data Collected by the State of Tennessee (CRM 10R)

A comprehensive monitoring station at CRM 10 is maintained by the Tennessee Division of Water Quality Control (data available on EPA STORET system station number 000680). Samples are collected monthly at a depth of 0.3 m (1 ft.) at 90 percent from the left bank facing the downstream direction and analyzed by State personnel.

A review of these data for the period March 1975 through October 1977 revealed that water quality conditions at CRM 10R were similar to the water quality conditions measured at the upstream TVA monitoring stations. Temperature levels and dissolved oxygen concentrations ranged from 6.0°C to 23.2°C and 5.8 mg/l to 13.1 mg/l, respectively. Temperatures and dissolved oxygen levels at CRM 10.0R were slightly higher in the winter months and slightly lower in summer months when compared to the upstream TVA stations, but due to a minimum number of observations, no distinct trends or causes can be identified. Dissolved oxygen saturation levels ranged from 66 to 105 percent.

Higher levels of turbidity, suspended solids, and color were recorded, which relates to the increased drainage area during periods of rainfall. Measured concentrations of sanitary-chemical constituents and metals were similar to the upstream stations, except for lead and coliform bacteria.

A lead concentration of 50 ug/l was observed on October 4, 1976. High total, fecal, and fecal streptococci coliform density ranges of 500 to 12,800; 165 to 7,955; and 182 to 250 per 100 ml, respectively, were measured at CRM 10R. The fecal to fecal streptococci ratios ranged from 0.15 to 295, thus providing no clear indication of the source of pollution.

Conclusions

Observed temperatures in the Clinch River were well below the Tennessee standard of 30.5°C. The river was well mixed in the vertical direction with thermal gradients normally below 1°C. It appears that during periods of reverse flow warmer water from Poplar Creek flows upstream elevating river water temperatures. This was observed at CRM 14.4 with the warmest water measured at the right bank area.

Dissolved oxygen concentrations of the Clinch River were good, being greater than or equal to 5.0 mg/l. The water was well mixed in the vertical direction, with dissolved oxygen gradients normally less than 0.5 mg/l. Isolated low concentrations of dissolved oxygen, ranging from 3.2 to 4.7 mg/l, were measured at Melton Hill Dam tailrace. But there appears to be sufficient reaeration capacity in the river to increase levels to 5.0 mg/l within a short distance. Dissolved oxygen percent saturation levels did not indicate any areas of unusual oxygen production which would be attributed to widespread photosynthetic activity or areas of serious reduction in dissolved oxygen concentrations.

Measured turbidity, suspended solids, and color levels increased in the downstream direction reflecting the quality of water from creeks and drainageways entering the river between CRM's 23.1 and 14.4.

Measured concentrations of nutrients, most metals, and sanitary-chemical constituents were normally low. Elevated concentrations of mercury and COD were observed on isolated occasions. Concentrations of iron and manganese were above levels identified for finished drinking water. The water is considered to be moderately hard.

During rainfall events the river was contaminated with high total coliform densities. The high nonfecal ratio would indicate that the source of the bacteria is soil and vegetation.

V. Literature Cited

1. U.S.E.P.A. Quality Criteria for Water. EPA-440/9-76-023, July 26, 1976.

2. U.S.E.P.A. National Interim Primary Drinking Water Regulations. C.F.R., Title 40, Part 141, V. 40, No. 248, December 1975.

3. U.S.E.P.A. Proposed National Secondary Drinking Water Regulations. C.F.R., Title 40, Part 143, V. 42, No. 62, March 1977.

VI. Site Stormwater Runoff Water Quality

VI. Site Stormwater Runoff Water Quality

Introduction

The site is drained by several small ephemeral drainageways which carry water only after periods of rainfall or snow melt. In order to determine background conditions prior to construction activities at the site, routine monthly surveys and/or special stormwater runoff surveys were conducted. During the period March through October 1975, monitoring stations were established in the Clinch River to measure the effect of site runoff on Clinch River water quality. In March 1976, the stations were relocated onsite to better address site stormwater runoff water quality by monitoring the water quality of four drainageways prior to mixing with the river.

Sediment generated from land erosion at the site is considered the most important runoff pollutant that affects water quality in the site area. This conclusion is based on agriculture and natural woodlands being the major land use within the area of interest. Therefore, the parameters selected for monitoring were turbidity and suspended solids. These parameters are directly related to erosion and soil loss associated with precipitation runoff. Soil particles can also transport nutrients, pesticides, organic matter, bacteria, and other pollutants. These parameters were not measured due to the lack of background sediment load data and the expense involved. These parameters are not believed to be significant at the site because of the past and present land usage.

Field and Laboratory Methods

Designated Clinch River stations for the measurement of stormwater runoff effects on the river were sampled on five occasions in 1975 during periods of rainfall. These surveys were conducted by personnel of the Water Quality and Ecology Branch. During the period June 1976 through October 1977, the site drainageway stations were visited by branch personnel periodically. No special surveys were conducted during periods of rainfall.

In November 1977, a rainfall notification system utilizing personnel at the TVA Kingston Steam Plant was established. Assigned personnel at the plant notified the Water Quality and Ecology Branch whenever a period of heavy rainfall (0.8 cm [0.3 in.] or more per hour, or 2.5 cm [1.0 in.] or more during 24 hours) was recorded at the plant. At the authorization of the Water Quality and Ecology Branch, one of these assigned personnel collected runoff samples during these events. The temperature and pH of the water were field determined. Through August 1978, runoff samples were also collected during routine monthly surveys. During most of the routine monthly surveys there was no flow in the drainageways.

All water quality samples were collected, samples handed, and field analyses performed in conformance with the Water Quality and Ecology Branch "Standard Methods for Routine Water Quality and Aquatic Biological Field Surveys," WQEB-SS-1, dated June 1, 1978. The analytical and sample preservation methods used for each water quality parameter is described in Appendix D. A listing of the data resulting from this monitoring activity is provided in Appendix A.

Results

An evaluation of the physical water quality of stormwater runoff leaving the site, as determined by the sampling of site drainageways,* showed that no clear correlation between daily total rainfall and physical water quality could be determined. The intensity of the rainfall rather than the total amount of rainfall had a more significant impact on physical water quality in the drainageways. A review of rainfall intensity data from the U.S. NOAA Climatological Data Station at Oak Ridge, Tennessee, revealed that intense rainfalls were recorded on April 18, 1978, and June 8, 1978. On these dates during and just prior to the time of sampling, rainfall intensity ranged from 0.15 to 1.1 cm/hr. (0.06 to 0.43 in./hr.) and 0.25 to 1.2 cm/hr. (0.10 to 0.47 in./hr.), respectively. The highest levels of suspended solids and turbidity measured during the monitoring period were observed on these dates (600 mg/l and 700 NTU [April 18], and 150 mg/l and 250 NTU [June 8], respectively).

Figure VI.1 and Figure VI.2 provide a graphical presentation of suspended solids and turbidity data, respectively, at three of the drainageway stations. Due to a lack of flow, the drainageway that enters the Clinch River at CRM 15.5 was only sampled three times and the data was not shown on the figures. The vertical lines in the figures illustrate the range between the maximum and minimum values on record. The rectangles illustrate the range in which 75 percent of the data were observed, the ends of which indicate the values below which 12.5 percent and 87.5 percent of the data were observed. The horizontal line within the rectangle

*The drainageways join the Clinch River at the right bank (of the site), facing the downstream direction.

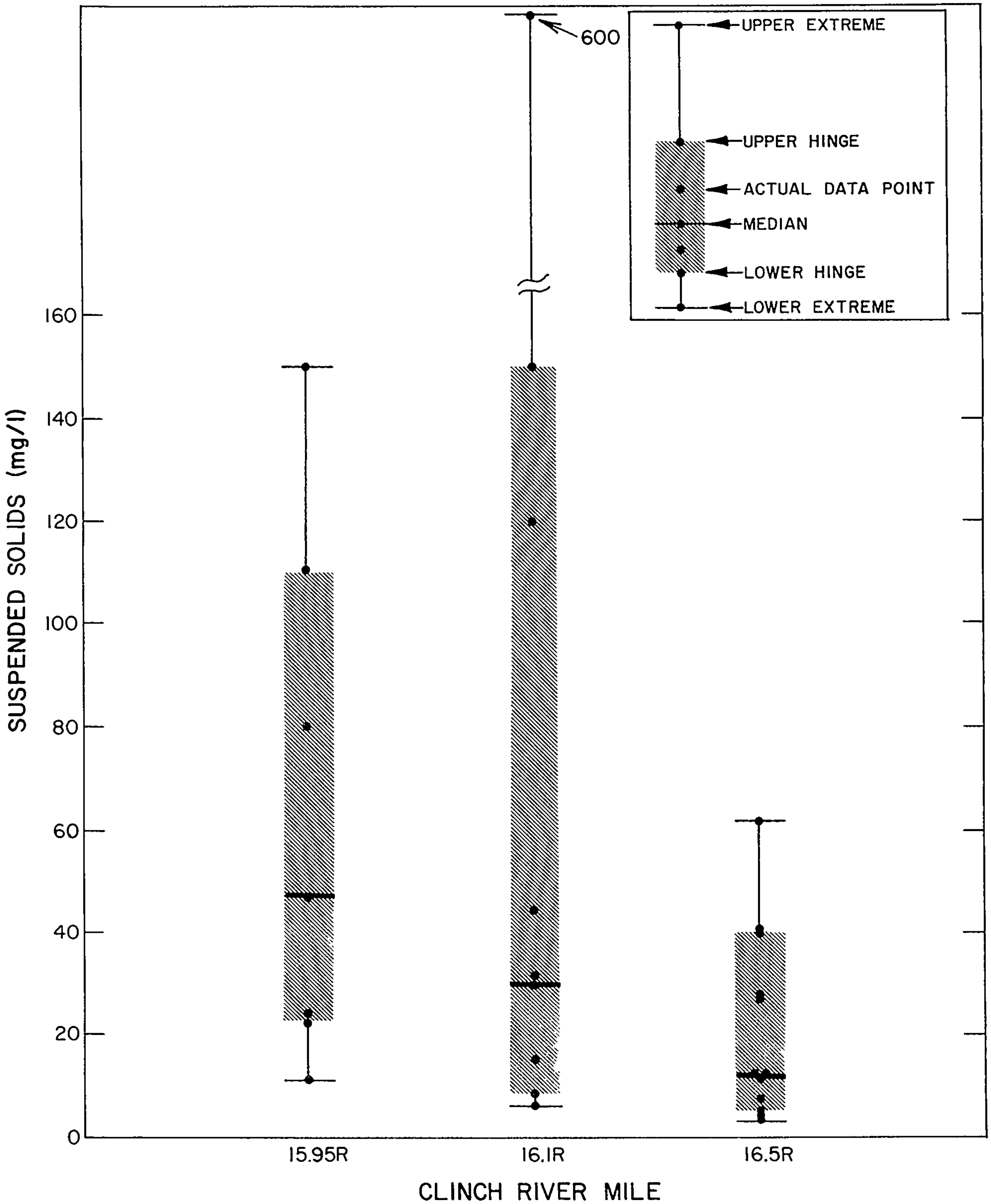

FIGURE VI.1 CONCENTRATIONS OF SUSPENDED SOLIDS IN STORMWATER RUNOFF FROM THE CRBRP SITE (1976-1978)

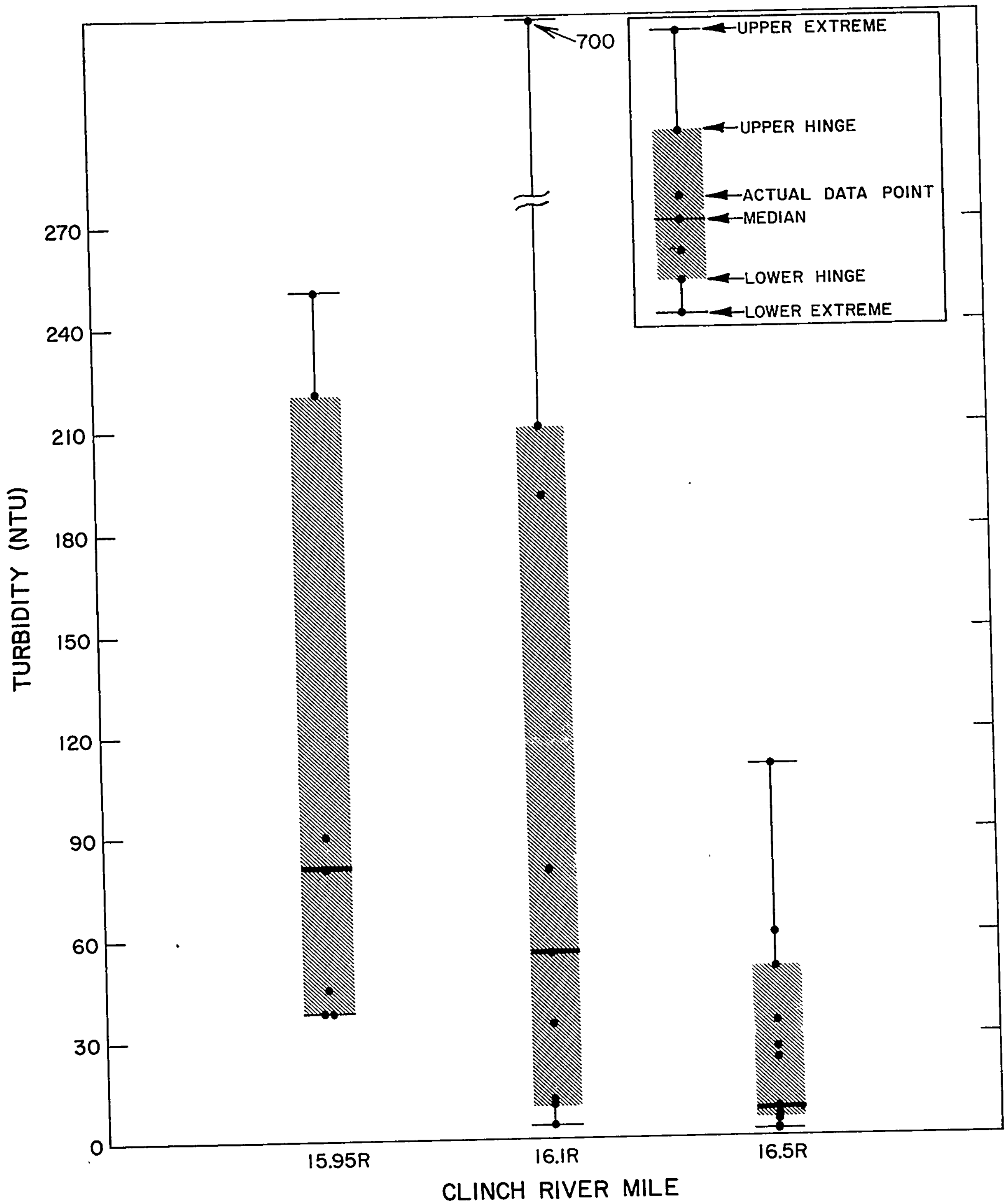

FIGURE VI.2 TURBIDITY LEVELS IN STORMWATER RUNOFF FROM THE CRBRP SITE (1976-1978) is the median value or that value below which and above which 50 percent of the data were observed. The points on the figures are the actual values observed.

Median suspended solids and turbidity values were much lower for the drainageway at CRM 16.5 due to the greater number of samplings during periods of little or no rainfall. This was the only drainageway flowing during many of the surveys.

A statistical evaluation of the stormwater runoff data showed the mean value for suspended solids to be 60 mg/l with one standard deviation resulting in values of -48 mg/l and 168 mg/l, respectively. The mean value for turbidity was calculated to be 85 NTU with one standard deviation resulting in values of -46 NTU and 216 NTU. The negative values obtained when the mean values were reduced by one standard deviation shows that the observed suspended solids and turbidity values varied considerably and did not plot as a normal distribution. Thus a logorithmic transformation of the data was necessary. Using the transformed suspended solids data, a mean value of 28 mg/l was calculated with one standard deviation resulting in values of 8.3 mg/l and 96 mg/l, and two standard deviations resulting in values of 2.4 mg/l and 324 mg/l. The transformed turbidity data showed a mean value of 37 NTU, with one standard deviation resulting in values of 8.7 NTU and 158 NTU, and two standard deviations resulting in values of 2.0 NTU and 676 NTU.

In 1975 five special rainfall surveys were performed consisting of sampling of the Clinch River at various locations in the site vicinity. Neither total rainfall nor rainfall intensity during the survey days can clearly be correlated to Clinch River physical water quality due to time delays between the rainfall events and surveys. As an example, on March 30, 1975, 8.33 cm (3.28 in.) of rainfall was recorded at Melton Hill Dam. A survey was performed on March 31, 1978. The resulting suspended solids and turbidity data were the highest measured during the instream stormwater monitoring program (1975). No significant variation with horizontal location was measured. A determination of whether the site was the source of the suspended solids and turbidity on this date can not be made. Therefore, the data resulting from this activity is useful only for background determinations in the Clinch River after rainfall events and can not be directly related to site stormwater runoff quality. The data resulting from this program is provided in Appendix A.

Conclusions

Rainfall intensity rather than the total amount of rainfall had a more significant impact on physical water quality in the drainageways. Surveys performed in conjunction with periods of intense rainfall resulted in the highest levels of suspended solids and turbidity measured in the drainageways. An evaluation of suspended solids and turbidity data showed that the observed values varied considerably and did not plot as a normal distribution. Logarithmic transformations of the data provided the following results:

	Suspended Solids (mg/l)	Turbidity (NTU)
Mean	28	37
One standard deviation	8.3, 96	8.7, 158
Two standard deviations	2.4, 324	2.0, 676

In 1975 five special rainfall surveys of the Clinch River were performed. Neither the total amount of rainfall or rainfall intensity could be clearly correlated to Clinch River physical water quality due to time delays between the rainfall events and surveys. In addition, a determination of whether the site was the source of the suspended solids and turbidity could not be made. Therefore, the data resulting from this activity is useful only for background determinations in the Clinch River after rainfall events. It is clearly shown by this evaluation that (1) rainfall intensity is significant to stormwater runoff quality, (2) the timing of stormwater runoff surveys is critical, and (3) stations located directly onsite upstream of any influence by the receiving waterbody, complemented with stations in the receiving waterbody, will provide the data necessary for an accurate assessment of the impact of site stormwater runoff on physical water quality in the receiving waterbody.

VII. Ground Water Quality

VII. Ground Water Quality

Introduction

As discussed in Chapter II the quality of ground water under the site is influenced by several geologic-hydrologic characteristics and controls of the region and most particularly the site. The evaluation of the quality of ground water under the site is based on data obtained from seven onsite observation wells. One of these wells was equipped with a submersible pump. The primary consideration in the sampling of wells is to obtain a representative sample of the formation by ensuring that the sample is not excessively aerated, agitated, or mixed with stagnant water standing in the well casing (i.e., in the casing there usually is limited vertical mixing and stratification can occur). This water can also contain foreign substances due to casing corrosion or introduction through the top of the casing. The six observation wells not equipped with a submersible pump were sampled by use of a siphon-type sampler with the standing water in the casing not being removed prior to sampling. Therefore, this evaluation is in two parts, pumped and siphoned samples.

Field and Laboratory Methods

For six of the wells a siphon-type sampler, which was a PVC pipe closed on both ends with inlet and outlet holes, was lowered into the well until it was about 3 m (10 ft.) below the static water level in the casing. The sample was brought to the surface and poured into the sample bottle. In the case of the one pumped well, the pump was permitted to run about five to ten minutes prior to sampling.

Temperature and pH were determined in the field. The analytical and sample preservation methods used for each water quality parameter is described in Appendix D. A listing of the data resulting from this monitoring activity is provided in Appendix A.

Results

An evaluation of water quality data obtained during the monitoring period from the pumped observation well shows the physical-chemical quality of the ground water to be good. Concentrations of dissolved solids were low, averaging 230 mg/l. The water had a high buffering capacity with bicarbonates the predominate form of alkalinity. Observed pH levels ranged from 6.2 to 7.35 S.U. Concentrations of analyzed nutrients and metals were normally low with concentrations of metals being below detectable limits on many occasions. Sodium concentrations up to 49 mg/l were observed.

An evaluation of water quality data from the nonpumped observation wells, which were sampled by the use of a siphon-type sampler, document that the quality of the water from these wells was poorer than the quality observed in water from the pumped well. Elevated concentrations of suspended solids, phosphorus, and sodium were measured. Concentrations of chromium, copper, nickel, and zinc were also observed to be greater than those concentrations in water obtained from the pumped well. Observed concentrations of cadmium, lead, and manganese in the nonpumped wells were greater than those concentrations identified by EPA drinking water criteria.[1,2]

Conclusions

An evaluation of all ground water data clearly showed a quality variation with differing sampling techniques. The sampling technique utilized for the nonpumped observation wells did not allow for the removal of the standing water in the casing. This resulted in a contaminated sample. The source of contamination would most likely be solids entering the casing from the host formation and corrosion of the metal casing. Additionally, acidification of a contaminated sample to a pH of 2.0 S.U. would dissolve suspended solids in the water and solubilize most metals contained in these solids. These solids normally would not be present in a sample obtained from a well properly flushed prior to sampling. Therefore, the data obtained from the unpumped wells did not properly represent the quality of water in the formation at the site and should not be construed as such.

An evaluation of the data obtained from the pumped well showed that at the site ground water quality was good. Concentrations of dissolved solids were low, averaging 230 mg/l. Concentrations of analyzed nutrients and metals were normally low and on many occasions below detectable limits.

VII. Literature Cited

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2. U.S.E.P.A. Proposed National Secondary Drinking Water Regulations. C.F.R., Title 40, Part 143, V. 42, No. 62, March 1977.

VIII. Phytoplankton

VIII. Phytoplankton

Introduction

Phytoplankton consist of microscopic, unicellular, and multicellular, nonvascular plants suspended in the water column and are almost entirely dependent on water currents for movement. The phytoplankton community in the Clinch River is commonly composed of taxa from the three major taxonomic divisions: (1) Chrysophyta, predominantly diatoms; (2) Chlorophyta, green algae; and (3) Cyanophyta, blue-green algae. Two other divisions are present which usually compose less than 10 percent of the phytoplankton assemblages and are Euglenophyta and Pyrrophyta (predominantly dinoflagellates). Most energy transfers in the aquatic ecosystem are dependent on the fixation of solar energy by these primary producers (Goldman, 1960; Reid, 1961).

It has been established that considerable variation occurs in day-to-day phytoplankton productivity rates (Rodhe et al., 1958; Goldman, 1960). Also, a distinctive feature of limnetic phytoplankton in temperate lakes is the great variation between seasonal populations, which are usually significantly greater than within seasonal population variations (Wetzel, 1975). However, bloom conditions at different time intervals within each season (especially summer and fall) can leave unanswered questions.

Available solar illumination, nutrients, temperature, and flow are probably the four main controlling factors for seasonal or monthly variations in the phytoplankton populations, diversity, biomass, and dominance of certain groups.

Field and Laboratory Methods

Different parameters were used to measure the phytoplankton community: (1) microscopic examination was used to enumerate and identify the various taxa present; (2) chlorophyll *a* was used for biomass determination; and (3) isotope tracer carbon-14 was used for productivity estimates.

Field

"Standard Methods for Routine Water Quality and Aquatic Biological Field Surveys" WQEB-SS-1, dated June 1, 1978, describe the field collection methods. A brief synopsis of these procedures follows. Phytoplankton samples for enumeration, chlorophyll, extraction, and primary productivity were collected at Clinch River Miles 14.4, 15.4, 17.9, and 19.0 with a non-metallic (Van Dorn) water sampler at the desired depth of each station (usually surface, 1, 3, and 5 m if depth permitted). Phytoplankton and chlorophyll samples were transferred to 1-ℓ Nalgene® bottles. The phytoplankton samples were later transferred to 100 ml Nalgene® bottles and preserved with Lugol's solution. Five hundred ml of the remaining sample in the 1-ℓ bottle were filtered through a 1.2 μm filter to retain the phytoplankton cells for chlorophyll *a* analysis. Each filter pad was wrapped in a Whatman filter paper and stored in a dessicator on dry ice until returned to the laboratory for analysis.

After collection of the primary productivity samples, they were transferred to clean 125 ml pyrex bottles, and 2.0 μCi of $Na_2C^{14}O_3$ was injected into each bottle with a plastic syringe. The bottles were suspended at the collection depth by a line from a float. At the 5-m depth a dark bottle was used with the clear bottle to compensate for the amounts of nonphotosynthetic assimilation of C^{14}. The C^{14} samples were incubated for three hours. After incubation, 1 ml of 10 percent Formalin was added to each bottle to stop the photosynthetic process and fix the products. The bottles were immediately placed in a lightproof box, and the samples upon return to shore were filtered through HA (0.45μ ± 0.02μ) Millipore® filters. The filters were placed in dessicators on dry ice in the dark until counted at the TVA Radiological Hygiene Branch laboratory.

Solar radiation at the water surface and through the water column was measured with a submarine photometer. This photometer consisted of an underwater sea cell and a matching deck cell for alternate surface and underwater illumination monitoring. Solar radiation was measured by a recording portable pyrohelimeter located near the incubation site for a period of 24 hours.

Laboratory

"Standard Methods for the Laboratory Analysis of Aquatic Biological Samples" WQEB-SS-2, dated June 1, 1978, describe the laboratory methods. A brief synopsis of these procedures follows: Phytoplankton samples were stored in a cool, dark place. Prior to enumeration each sample was mixed and a 15 ml random subsample was placed into a sedimentation counting chamber. After a minimum of 12 hours each sample was identified and enumerated by using an inverted microscope (32 ox). The bench sheets were coded and sent to the computer center for final computation.

Phytopigments--Chlorophyll a was extracted from each filter with 90 percent acetone for a period of at least 24 hours in the dark at 4°C. Chlorophyll absorption was determined with a spectrophotometer (narrow band, 1 cm light path) at optical densities of 750, 663, 645, and 630 nm using a 90 percent acetone blank. The optical densities were computerized and chlorophyll concentrations were determined using the equations of Richards and Thompson (1952), as modified by Parsons and Strickland (1963).

Primary Productivity--Carbon-14 activity on the filters was measured with a thin-window, low background, gas-flow proportional Beckman counter by the TVA Radiological Hygiene Branch. Total inorganic carbon available for photosynthesis (mg c/ℓ) was calculated using total alkalinity (titrametric method) values, pH, and temperatures from the conversion table of Bachmann (1962).

The C^{14} method adapted to this study was first used by Steeman-Nielson (1952). By comparing a ratio of total incident light with light available during the incubation period, productivity during the incubation period was extrapolated to total productivity per day (mg c/m^2/day).

Results

The total number of phytoplankton taxa sampled from March 1975 through October 1975 at CRM 14.4, CRM 15.4, CRM 17.9, and CRM 19.0 were comprised of 22 Chrysophyta, 51 Chlorophyta, 12 Cyanophyta, 4 Euglenophyta, and 4 Pyrrophyta genera (Table B.1.1, Appendix B). Some genera were quite common throughout the Clinch River and were found at one or more locations during each sampling period.

Melosira was found at each station except CRM 19.0 on August 1975. *Synedra* was documented at CRM 14.4 on every sampling trip and *Stephanodiscus* was documented on every sampling trip at CRM 17.9 and 19.0.

Chlamydomonus was documented at all locations and Scenedesmus was only documented on all occasions at CRM 17.9.

Dactylococcopis was sampled on every occasion at all river miles except CRM 19.0 and Anacystis was always found at CRM 14.4 and 15.4.

The genus Trachelomonas was always found at only CRM 19.0.

These various genera of the different groups are shown in table B.1.1 of Appendix B.

Genera documented within the study area only once during the study period were: Eunotia, Neidium, Staunoneis, Surirella, Stigeoclonium, Dactylococcus, Microspora, Pleodorina, Sphaerocystis, Aphanocapsa, Lyngbya, and Aphanothece.

The composition of taxa found within the study area is summarized at each of the four stations in table VIII.1. Chlorophyta had more genera represented, followed by Chrysophyta and Cyanophyta. Cyanophyta had the highest coefficient of variation (CV) with 15.27 percent followed by Chrysophyta 14.42 percent, Chlorophyta 3.53 percent and Euglenophyta and Pyrrophyta had no mean deviation.

The standing crop estimates, percent composition, and most abundant major algal divisions are summarized in table VIII.2 and table B.1.2 of Appendix B. Chrysophyta was generally most abundant during March, May, and August; Chlorophyta was most abundant during April and July; and Cyanophyta was most abundant during June, September, and October.

The maximum phytoplankton standing crop occurred in October with approximately 2 million or more cells/ℓ and documented at all stations (Figure VIII.1 and table B.1.3 [Appendix B]). In March and April the populations did not exceed 200,000 cells/ℓ. The coefficient of variation

Table VIII.1

PHYTOPLANKTON GENERA WITHIN THE VICINITY OF THE CRBRP PROJECT - CLINCH RIVER, MARCH 1975 - DECEMBER 1975 INDICATING NUMBERS OF DIFFERENT KINDS OF GENERA, DEVIATION FROM MEAN, AND COEFFICIENT OF VARIATION.

	CRM 14.4	CRM 15.4	CRM 17.9	CRM 19.0	$\bar{x}$	Mean Deviation	Coefficient of Variation
Chrysophyta	20	15	16	15	16.50	2.38	14.42%
Chlorophyta	39	39	42	40	40.00	1.41	3.53%
Cyanophyta	10	8	7	8	8.25	1.26	15.27%
Euglenophyta	4	4	4	4	4.00	0	0%
Pyrrophyta	4	4	4	4	4.00	0	0%

Table VIII.2.

DOMINANT COMPOSITION OF MAJOR PHYTOPLANKTON DIVISIONS

(CHRYSOPHYTA, CHLOROPHYTA, CYANOPHYTA DURING 1975)

(March - October)

CRM	March	April	May	June	July	August	September	October
14.4	Chrys	Chlor	Chrys	Cyan	Chlor	Chrys	Cyan	Cyan
15.4	Chrys	Chlor	Chrys	Cyan	Chlor	Chrys	Cyan	Cyan
17.9	Chrys	Chlor	Chlor	Cyan	Chlor	Chrys	Cyan	Cyan
19.0	Chrys	Chlor	Chrys	Cyan	Chlor	Chlor	Chlor	Chlor

Chrysophyta = Chrys
Chlorophyta = Chlor
Cyanophyta = Cyan

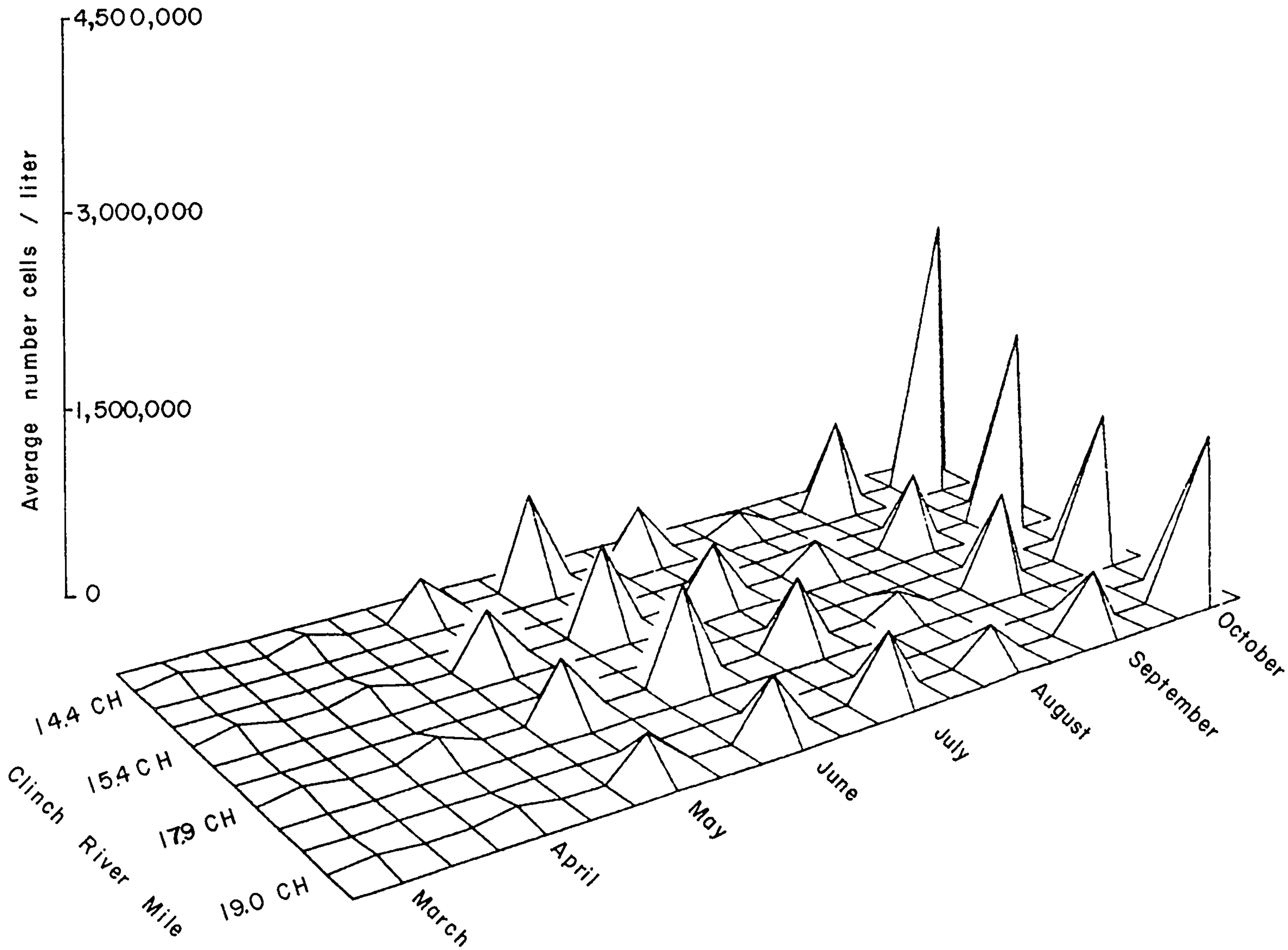

Figure VIII.1. Summary of standing crop estimates for phytoplankton community within the vicinity of the CRBRP Project, Clinch River - March 1975 through October 1975.

for the four stations over the study period was 13.04 percent. Standing crop estimates tended to gradually increase in the downstream direction from CRM 19.0 to CRM 14.4 (Table B.1.3 Appendix B) from near 1,000,000 cells/ℓ to about 700,000 cells/ℓ by averaging all samples throughout the sampling period. This pattern was not always true by observing individual monthly observations but usually followed the same trend.

Chlorophyll a levels are summarized in Figure VIII.2 and table B.1.4 (Appendix B). The maximum chlorophyll a concentrations were documented during June 1975 at all stations with values ranging from 14 mg chl a/m^2 to over 21 mg chl a/m^2. The chlorophyll measurements were generally less from March through May than during June through October. Average values generally increased downstream from CRM 19.0 with the exception at CRM 17.9 with values being slightly higher than those at CRM 15.4. The comparison of the mean of all stations over the study period yielded a mean coefficient of variation of 4.76 percent.

Figures VIII.3, Figure VIII.4, and Table VIII.3 and Tables B.1.5 and B.1.6 (Appendix B) summarize the phytoplankton productivity values for mg c/m^2/day assimilated by he phytoplankton during the sampling period of 1976 and 1977.

During 1976 phytoplankton productivity values continuously increased downstream on the right overbank, left overbank, and in the channel. October was the most productive month. Values were relatively low from March through May, increased in June, then gradually decreased from June through September. Productivity values were also greater in the channel than on the right and left overbank areas. The overbank areas were generally

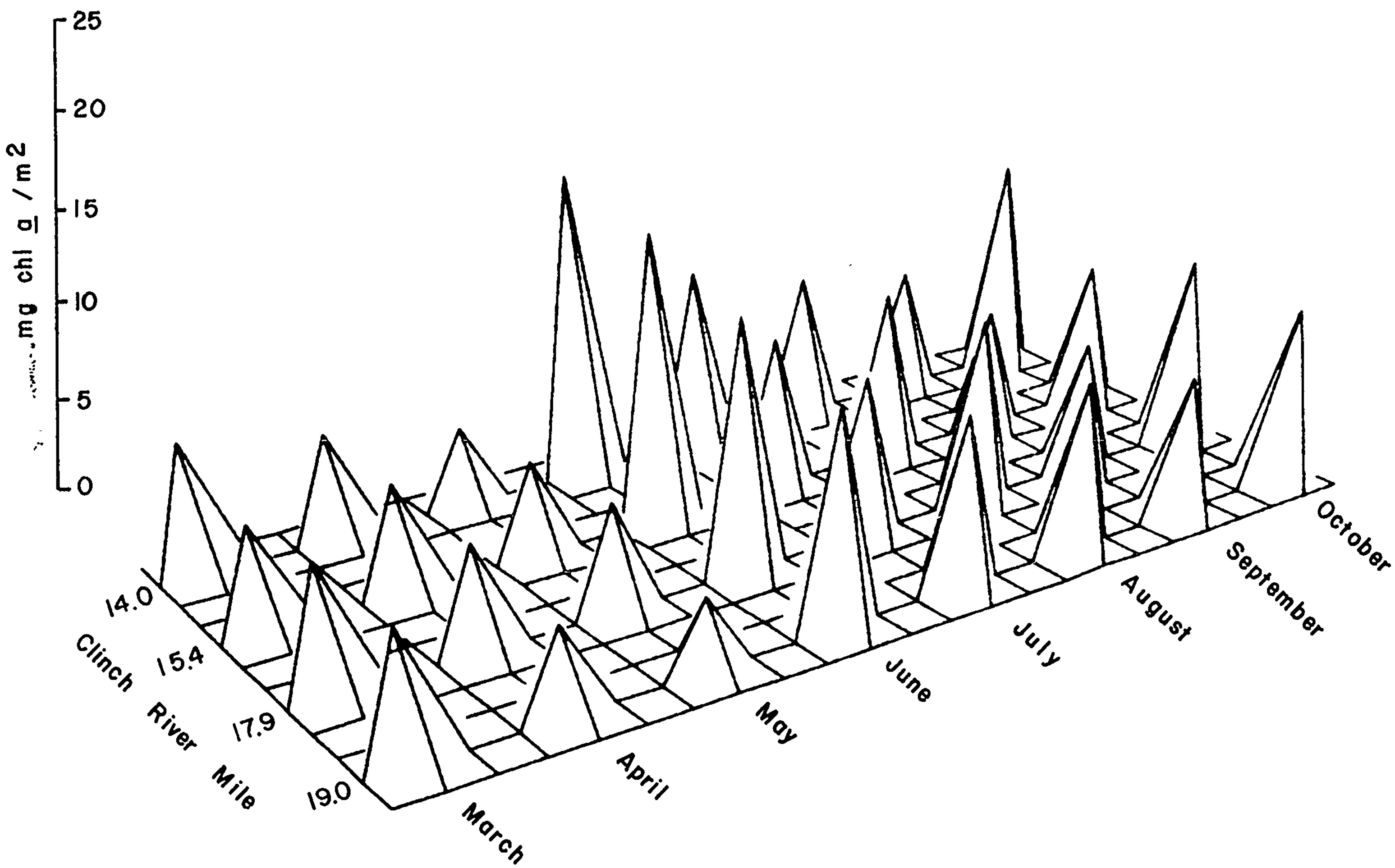

Figure VIII.2. Summary of average chlorophyll a values (March through October 1975).

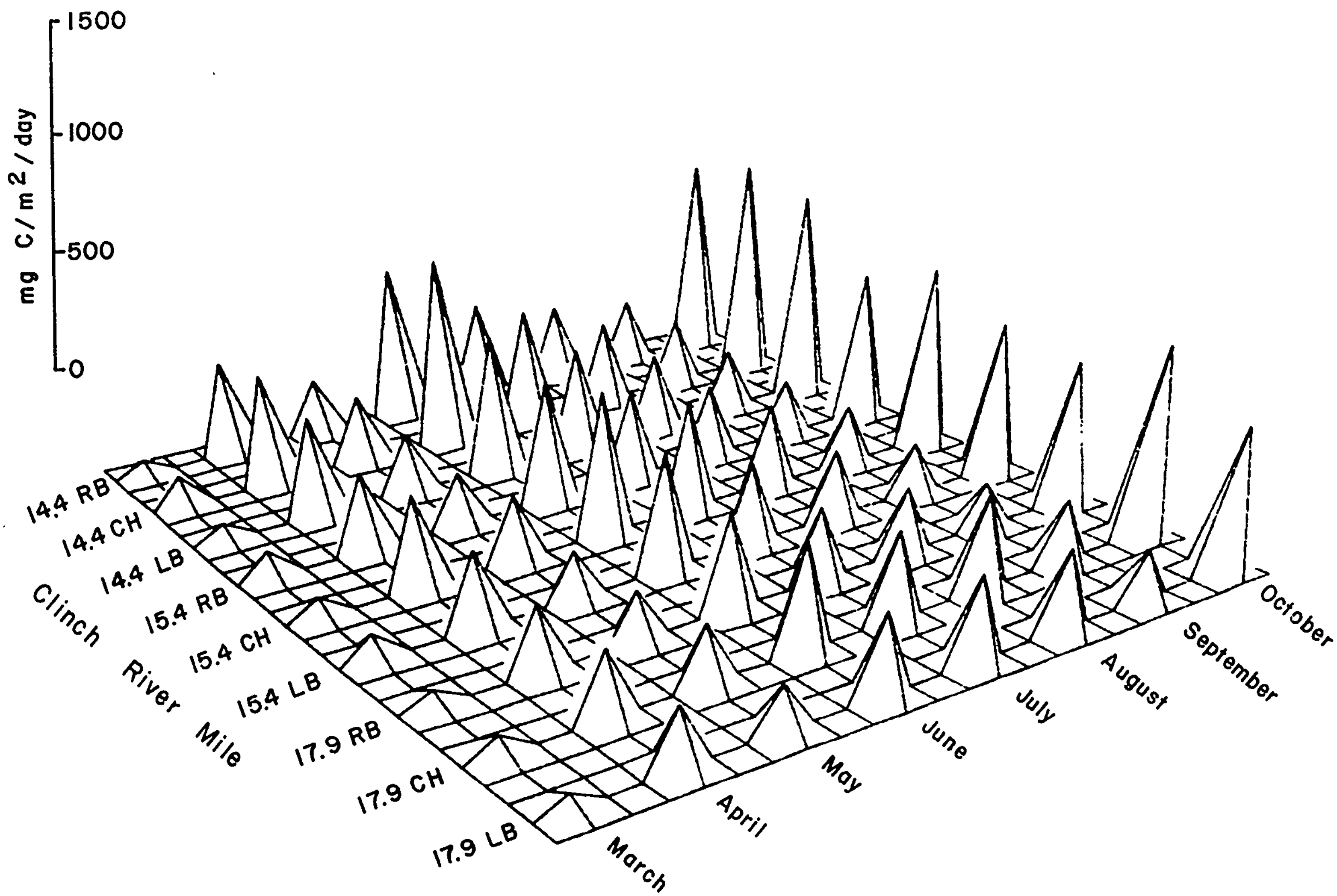

Figure VIII.3. Phytoplankton productivity average values for all samples by river miles and months (March through October 1976).

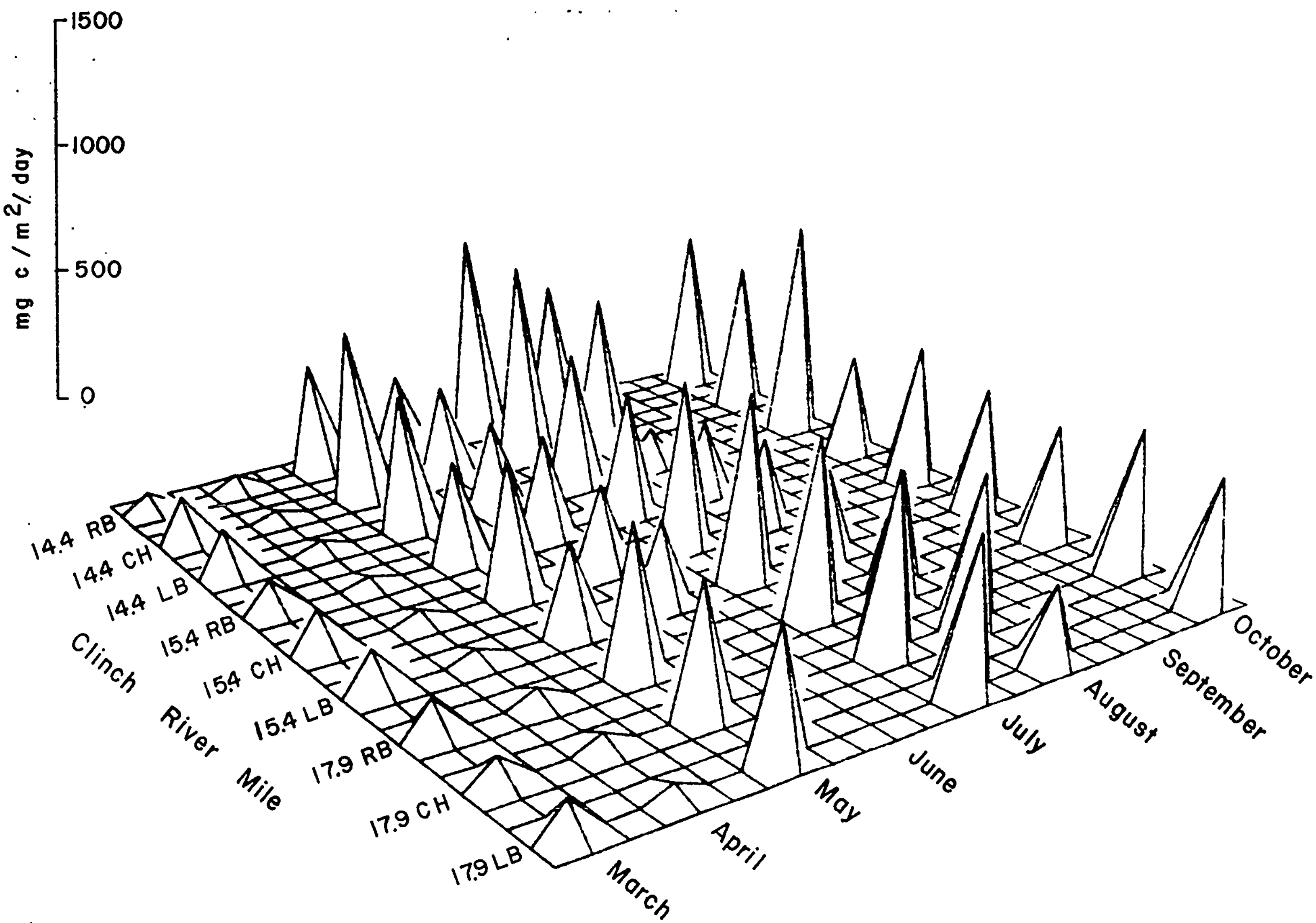

Figure VIII.4. Phytoplankton productivity average values for all samples by river miles and months (March through October 1977).

Table VIII.3

SUMMARY OF PRIMARY PRODUCTIVITY (C-14), DATA AT LEFT OVERBANK, RIGHT OVERBANK, AND CHANNEL OF CRM'S 14.4, 15.4, AND 17.9 SHOWING MEAN VALUES, MEAN DEVIATION AND COEFFICIENT OF VARIATION FOR 1976 AND 1977

CRM	March-October mg C/m^2/day	Mean Deviation	Coefficient of Variation
		1976	
(Right Overbank)			
14.4	537		
15.4	459		
17.9	394		
	463	71.50	15.44%
(Channel)			
14.4	630		
15.4	535		
17.9	492		
	552	71.07	12.86%
(Left Overbank)			
14.4	541		
15.4	442		
17.9	405		
	464	40.78	8.81%
		1977	
(Right Overbank)			
14.4	560		
15.4	409		
17.9	521		
	497	78.28	15.76%
(Channel)			
14.4	624		
15.4	494		
17.9	550		
	556	64.96	11.68%
(Left Overbank)			
14.4	503		
15.4	459		
17.9	468		
	475	24.04	5.06%

similar in productivity rates. The coefficient of variation of the means ranged from 8.81 percent to 15.44 percent for the different areas.

During 1977 phytoplankton productivity rate increased from CRM 17.9 to CRM 14.4, but decreased from CRM 17.9 to CRM 15.4. July was the most productive month except on the left overbank at CRM 15.4 where the highest values occurred during October. High values were also found throughout the sampling reach during May, July, and October. The least productive months were March, April, and August at most locations. Samples were not taken during September at any stations nor at CRM 17.9 during June. The mean coefficient of variation ranged from 5.06 percent to 15.76 percent for the different areas.

Tables B.1.5 and B.1.6 (Appendix B) also indicate hourly productivity rates per unit volume (by depth, mg $c/m^3/hr$). In all cases available light was reduced to less than 5 percent at a depth of 5 meters and productivity also diminished to less than 5 mg $c/m^3/hr$. In some cases productivity was highest at one m, rather than the surface due to intense solar radiation resulting in phyto-toxicity before the intense light rays were filtered out by the water. This was the case about half the time throughout the sampling reach.

Conclusions

The most common phytoplankton genera found throughout the sampling reach were *Melosira*, *Synedra*, *Stephanodiscus*, *Chlamydomonus*, *Scenedesmus*, *Dactylococcopis*, *Anacystis*, and *Trachelomonas*. Generally the Chrysophytes were dominant mostly during the spring, the Chlorophyta during the summer, and the Cyanophytes during the fall.

Numbers of phytoplankton generally start increasing during May with the largest peaks occurring in October. Highest concentrations were over 3,700,000 cells/ℓ at CRM 14.4 during October. Concentrations of less than 100,000 cells/ℓ only occurred during March at CRM's 17.9 and 19.0.

Chlorophyll a and productivity rates generally followed the same pattern, especially with relatively lower values during March, April, and May. May was an exceptional month during 1977 for productivity rates with higher than usual values. The comparisons of 1976 and 1977 productivity rates show similarity with normal annual variations caused by seasonal temperature and turbidity differences in the water.

All three phytoplankton parameters (standing crop, chlorophyll a, and primary productivity) indicated a patchy distribution primarily controlled by a continuous moving flow pattern of the Clinch River with increases observed downstream from CRM 19.0 as the water mass velocity decreased and the retention time became longer. Productivity was also greater in the channel areas than in the overbank areas for surface area measurements due to deeper waters, but similar for per unit area measurements.

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IX. Periphyton

IX. Periphyton

Introduction

Periphyton comprises an important community of microorganisms that are attached to but do not penetrate a substrate. Wetzel (1975) in a recent definition refers to periphyton as simply the microfloral growth upon substrata, but works as early as Young's (1945) refer to a periphyton as an assemblage of organisms growing upon free surfaces of submerged objects in water exclusive of those organisms belonging to the benthos. As such the term periphyton is synonymous with the term "aufwuchs" as given by Ruttner (1953). This report refers to periphyton in the same context as Ruttner.

The environmental conditions that affect the phytoplankton community also influence the periphyton community. Yet the physical characteristics of the substrate are an important factor in determining the community structure. The nature of the substrate provides a suitable basis on which to subdivide the periphyton biocenose. These subdivisions include epiphytic (plant), epizooic (animal), epidendritic (wood), epipelic (sediment), and eiplithic (rock).

The periphyton community includes autotrophic and heterotrophic organisms. The former representing the segment of the community that synthesizes energy and is predominantly composed of photosynthesizing algae. The latter represents a variety of organisms such as rotifers and fungi that depend primarily upon organic material for their nutrition.

The periphyton community is dominated by attached algae and as such are important primary producers in waterways, and often constitute the major algal biomass in streams and rivers since the plankton are poorly developed in these waters (Wetzel, 1975). In addition, periphyton can adjust to short-term changes of environmental conditions, but long-lasting alterations are reflected in the qualitative and quantitative composition of periphyton assemblage (Sladekova, 1966). It is these qualities that make periphyton an important tool in the study of water quality.

The collection and measurement of periphyton has been done on both natural and artificial substrates. Artificial substrates provide a standardized surface for periphyton to colonize and because of ease of replication provide a more precise estimate of standing crop. Several disadvantages include (1) the natural substrate is not duplicated, thus the community that develops may include species that are not representative of the natural periphyton community, and (2) the use of artificial substrates is adversely affected by turbidity, current, wave action, vandalism, and loss. However, Becker (1975) considers artificial substrates as the best method of making quantitative assessments of the periphyton community under a wide range of environmental conditions, including organic and thermal enrichment.

Field and Laboratory Methods

Samples of the periphyton community were obtained on a monthly basis from April 1975 to September 1975 using artificial substrates. Two racks of five 1.5 c/m^2 Plexiglass® slides were suspended 0.5 meter beneath the water surface at CRM 14.4, CRM 15.4, CRM 17.9, and CRM 19.0.

The slides were incubated for a period of four weeks before retrieval. After the incubation period, the slides were collected, placed in individual plastic bags, and stored frozen until analyzed. One slide from each rack was set aside for phytoperiphyton identification. All other slides were used to determine the autotrophic index.

Autotrophic indices, ash free dry weights, and phytoperiphyton identification and enumeration were done according to procedures outlined in the Tennessee Valley Authority's Quality Assurance Procedure No. WQEB-SS-2 (1978). The procedures used in 1975 were the same as those outlined in the above procedural handbook.

Results

The quantitative enumeration and percentage composition of the major algal divisions collected from April to September 1975 are presented in Table IX.1. A list of the taxa collected and their spatial and temporal distributions are given in Table IX.2. Data were not available for river miles 14.4, 17.9, and 19.0 during April; or for any of the stations during June and July because of missing substrates, and inadvertent mishandling of slides in the laboratory.

The Chrysophyta (diatoms) dominated the periphyton community in both abundance and number of taxa. Seventeen Chrysophyta genera were collected with the number of genera per substrate ranging from six to fifteen. *Achnanthes* was the dominant Chrysophyta genus with the exception of CRM 15.4 (April 1975). This taxa represented from 32.5 percent to 99 percent of the Chrysophyta standing crop. The genus *Navicula* was dominant in April (CRM 15.4) and the genera *Cymbella*, *Melosira*, and *Synedra* contributed to the standing crop in May at river miles 17.9 and 19.0.

Table IX.1

Quantitative Enumeration and Percentage Composition of

Major Algal Divisions Colonizing Artificial Substrates,

in the Vicinity of the Proposed CRBRP - 1975[1]

Date	River Mile	Algal Division	No. Taxa	Cells x $10^6/M^2$	Percent Composition	Dominant** Species
April 16	15.4	Chrysophyta	10	49.72	95.2	Navicula
		Chlorophyta	1	1.71	3.3	Oedogonium
		Cyanophyta	2	.78	2.5	Oscillatoria
		Pyrrophyta	0	0	0.0	
May 22	14.4	Chrysophyta	12	407.10	95.0	Achnanthes
		Chlorophyta	2	19.24	4.5	Stigeoclonium
		Cyanophyta	2	2.24	0.5	Merismopedia
		Pyrrophyta	0	0	0.0	
May 22	15.4	Chrysophyta	11	1,318.58	97.0	Achnanthes
		Chlorophyta	3	41.28	3.0	Stigeoclonium
		Cyanophyta	1	.06	*	Oscillatoria
		Pyrrophyta	0	0	0.0	
May 22	17.9	Chrysophyta	15	8,026.19	97.2	Achnanthes
		Chlorophyta	5	230.52	2.8	Stigeoclonium
		Cyanophyta	1	3.81	*	Dactylococcopsis
		Pyrrophyta	0	0	0.0	
May 22	19.0	Chrysophyta	14	1,977.39	80.3	Achnanthes
		Chlorophyta	4	486.41	19.7	Stigeoclonium
		Cyanophyta	1	.32	*	Dactylococcopsis
		Pyrrophyta	0	0	0.0	
May 22	19.0	Chrysophyta	9	2,243.14	73.7	Achnanthes
		Chlorophyta	2	801.05	26.3	Stigeoclonium
		Cyanophyta	2	.38	*	Dactylococcopsis
		Pyrrophyta	0	0	0.0	

Table IX.1
(Continued)

Date	River Mile	Algal Division	No. Taxa	Cells x $10^6/M^2$	Percent Composition	Dominant** Species
August 7	14.4	Chrysophyta	8	4,461.51	99.2	Achnanthes
		Chlorophyta	7	36.20	0.8	Stigeoclonium
		Cyanophyta	0	0	0.0	
		Pyrrophyta	0	0	0.0	
August 7	14.4	Chrysophyta	8	3,048.64	99.2	Achnanthes
		Chlorophyta	5	23.81	0.8	Stigeoclonium
		Cyanophyta	0	0	0.0	
		Pyrrophyta	0	0	0.0	
August 7	15.4	Chrysophyta	9	3,676.33	99.9	Achnanthes
		Chlorophyta	1	4.76	0.1	Stigeoclonium
		Cyanophyta	0	0	0.0	
		Pyrrophyta	0	0	0.0	
August 7	15.4	Chrysophyta	8	6,043.30	84.1	Achnanthes
		Chlorophyta	1	1,137.88	15.9	Stigeoclonium
		Cyanophyta	0	0	0.0	
		Pyrrophyta	0	0	0.0	
August 7	17.9	Chrysophyta	6	5,429.13	99.5	Achnanthes
		Chlorophyta	1	26.98	0.5	Stigeoclonium
		Cyanophyta	0	0	0.0	
		Pyrrophyta	0	0	0.0	

Table IX.1
(Continued)

Date	River Mile	Algal Division	No. Taxa	Cells x $10^6/M^2$	Percent Composition	Dominant** Species
August 7	17.9	Chrysophyta	8	3,145.55	96.9	Achnanthes
		Chlorophyta	2	55.55	1.7	Stigeoclonium
		Cyanophyta	1	45.22	1.4	Anacystis
		Pyrrophyta	0	0	0.0	
August 7	19.0	Chrysophyta	7	2,637.59	97.4	Achnanthes
		Chlorophyta	2	71.42	2.6	Stigeoclonium
		Cyanophyta	0	0	0.0	
		Pyrrophyta	0	0	0.0	
August 7	19.0	Chrysophyta	8	4,170.64	96.2	Achnanthes
		Chlorophyta	1	150.77	3.5	Stigeoclonium
		Cyanophyta	1	11.11	0.3	Anacystis
		Pyrrophyta	0	0	0.0	
September 16	14.4	Chrysophyta	9	3,688.19	93.7	Achnanthes
		Chlorophyta	3	245.99	6.3	Stigeoclonium
		Cyanophyta	1	1.02	*	Lyngbya
		Pyrrophyta	0	0	0.0	
September 16	14.4	Chrysophyta	9	3,258.11	99.5	Achnanthes
		Chlorophyta	2	5.87	0.2	Stigeoclonium
		Cyanophyta	1	9.55	0.3	Oscillatoria
		Pyrrophyta	0	0	0.0	
September 16	15.4	Chrysophyta	8	947.42	87.2	Achnanthes
		Chlorophyta	2	139.07	12.8	Stigeoclonium
		Cyanophyta	1	.68	*	Oscillatoria
		Pyrrophyta	0		0.0	

Table IX.1
(Continued)

Date	River Mile	Algal Division	No. Taxa	Cells x $10^6/M^2$	Percent Composition	Dominant** Species
September 16	15.4	Chrysophyta	10	4,749.89	97.1	Achnanthes
		Chlorophyta	1	139.66	2.9	Stigeoclonium
		Cyanophyta	0	0	0.0	
		Pyrrophyta	0	0	0.0	
September 16	17.9	Chrysophyta	7	1,807.59	92.5	Achnanthes
		Chlorophyta	1	147.59	7.5	Stigeoclonium
		Cyanophyta	0	0	0.0	
		Pyrrophyta	0	0	0.0	
September 16	17.9	Chrysophyta	6	2,045.64	91.6	Achnanthes
		Chlorophyta	1	187.27	8.4	Stigeoclonium
		Cyanophyta	0	0	0.0	
		Pyrrophyta	1	1.59	*	Glenodinium
September 16	19.0	Chrysophyta	5	2,227.26	88.0	Achnanthes
		Chlorophyta	1	304.70	12.0	Stigeoclonium
		Cyanophyta	0	0	0.0	
		Pyrrophyta	0	0	0.0	
September 16	19.0	Chrysophyta	12	1,412.37	90.0	Achnanthes
		Chlorophyta	4	156.78	10.0	Stigeoclonium
		Cyanophyta	1	.25	*	Lyngbya
		Pyrrophyta			0.0	

1. Data were not available for June, July, and River Miles 14.4, 17.9, 19.0 during April because of missing substrates and inadvertent mishandling of samples in the laboratory.

* Percentage is less than .01.

** Dominant species for each algal group.

Table IX.2

Spatial and Seasonal Distribution of Phytoperiphyton Taxa

Within the Vicinity of the Proposed CRBRP, Clinch River - 1975

TAXA	April				May				June				July				August				September			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
CHRYSOPHYTA																								
Achnanthes spp.		x			x	x	x	x									x	x	x	x	x	x	x	x
Asterionella spp.		-			-	-	x	x									-	-	-	-	-	-	-	-
Caloneis sp.		-			x	-	-	-									-	-	-	-	-	-	-	-
Cocconeis spp.		x			x	x	x	x									-	x	-	x	x	x	-	x
Cyclotella spp.		-			x	-	x	x									-	x	-	-	-	-	-	x
Cymbella spp.		x			x	x	x	x									x	x	x	x	x	x	x	x
Diatoma spp.		-				x	x	x									x	x	x	x	x	x	x	x
Fragilaria spp.		-			x	-	x	x									x	-	-	-	-	-	-	-
Gomphonema spp.		x			x	x	x	x									x	x	x	x	x	x	x	x
Gyrosigma spp.		x			x	x	x	x									-	-	x	-	-	x	-	x
Melosira spp.		x			x	x	x	x									x	x	x	x	x	x	x	x
Navicula spp.		x			x	x	x	x									x	x	x	x	x	x	x	x
Nitzschia spp.		x			x	x	x	x									x	x	x	x	x	x	x	x
Pinnularia spp.		-			-	-	-	-									-	-	-	-	-	x	-	x
Rhoicosphenia spp.		-			-	-	x	x									-	-	-	-	-	-	-	-
Stephanodiscus spp.		x			-	x	x	x									-	-	-	-	-	-	-	-
Synedra spp.		x			x	x	x	x									x	x	x	x	x	x	x	x
CHLOROPHYTA																								
Ankistrodesmus spp.		-			-	-	-	-									x	-	-	-	-	-	-	x
Chlorella spp.		-			-	-	-	-									x	-	-	-	-	-	-	-
Cosmarium spp.		-			-	-	-	-									x	-	-	-	x	-	-	-
Kirchneriella spp.		-			-	-	x	x									-	-	-	-	-	-	-	-
Mougeotia spp.		-			-	-	-	-									x	-	-	-	-	-	-	x
Oedogonium spp.		x			x	-	-	-									-	-	-	-	x	x	-	-
Protococcus sp.		-			-	-	x	x									-	-	-	-	-	-	-	-
Scenedesmus spp.		-			-	x	x	x									x	-	x	x	x	-	-	x
Schroederia sp.		-			-	x	x	-									-	-	-	-	-	-	-	-
Stigeoclonium spp.		-			x	x	x	x									x	x	x	x	x	x	x	x
Tetrastrum spp.		-			-	-	-	-									x	-	-	-	-	-	-	-
Unidentified green		-			-	-	-	-									x	-	-	-	-	-	-	-
CYANOPHYTA																								
Anacystis spp.		-			-	-	-	-									-	-	x	x	-	-	-	-
Dactylococcopsis spp.		x			-	-	x	x																
Lyngbya spp.		-			-	-	-	-									-	-	-	-	x	-	-	x
Merismopedia spp.		-			x	-	-	-									-	-	-	-	-	-	-	-
Oscillatoria spp.		x			x	x	-	-									-	-	-	-	x	x	-	-
PYRROPHYTA																								
Glenodinium spp.		-			-	-	-	-									-	-	-	-	-	-	-	x

1. CRM 14.4
2. CRM 15.4
3. CRM 17.9
4. CRM 19.0

x = Presence of genus
- = Absence of genus
Blank = Artificial substrates missing or samples inadvertently mishandled in the laboratory

Stigeoclonium was the dominant Chlorophyta (green algae) (Table IX.1) with the exception of Oedogonium being dominant in April (CRM 15.4). Twelve taxa, including one unidentified taxon, were collected during the study period. The percentage composition of Chlorophyta per substrate ranges from 0.1 percent (August, CRM 15.4) to 23.6 percent (May, CRM 19.0). Scenedesmus was second to Stigeoclonium in occurrence.

Five genera of Cyanophyta (blue-green algae) were identified with each genus being dominant at some time during the year. The percent composition of Cyanophyta ranged from less than 0.01 percent to 2.5 percent in April.

Glenodinium was the only Pyrrophyta collected. It was collected in September 1975 at river mile 17.9.

Periphytic biomass, chlorophyll a concentrations, and autotrophic index values are summarized in Table IX.3. Like the quantitative enumeration, information was not obtained at some locations. However, the number of substrates available were greater than the number used for quantitative enumeration. For biomass data, 124 substrates were used while 22 were used for quantitative enumeration.

The autotrophic index ranged from 251.59 (August, CRM 17.9) to 602.2 (May, CRM 14.4). The mean autotrophic index and the 95 percent confidence limits for each station throughout the year are presented in Figure IX.1.

Table IX.3

Summarization of Periphyton Biomass, Chlorophyll a Content and Autotrophic Index Values within the Vicinity of the Proposed CRBRP, Clinch River - 1975

Date	Station	Average Biomass (mg Ash-free Dry Weight/m^2)	Average Chlorophyll a Biomass (mg/m^2)	Average AI	Replicate Samples
4-16-75	CRM 14.4	-	-	-	-
	CRM 15.4	313.87	0.83	367.73	4
	CRM 17.9	-	-	-	-
	CRM 19.0	-	-	-	-
5-22-75	CRM 14.4	7188.53	13.23	602.02	4
	CRM 15.4	16961.13	52.16	345.37	4
	CRM 17.9	13223.46	45.36	291.08	4
	CRM 19.0	13225.00	43.60	332.28	4
6-18-75	CRM 14.4	-	-	-	-
	CRM 15.4	5316.88	15.64	380.24	8
	CRM 17.9	5085.97	18.29	342.07	4
	CRM 19.0	7628.94	19.24	425.37	8
7-15-75	CRM 14.4	9364.73	17.17	562.29	4
	CRM 15.4	11889.55	26.41	458.10	8
	CRM 17.9	9696.38	23.91	415.70	8
	CRM 19.0	-	-	-	-
8-7-75	CRM 14.4	3528.00	8.40	442.39	8
	CRM 15.4	2341.82	7.92	334.03	8
	CRM 17.9	4017.64	16.02	251.59	8
	CRM 19.0	4639.81	18.17	261.05	8
9-16-75	CRM 14.4	7885.79	21.00	379.63	8
	CRM 15.4	3837.73	8.19	474.72	8
	CRM 17.9	3787.07	11.03	349.39	8
	CRM 19.0	4531.16	13.34	339.25	8

- = Artificial substrates missing or inadvertently mishandled in the laboratory.

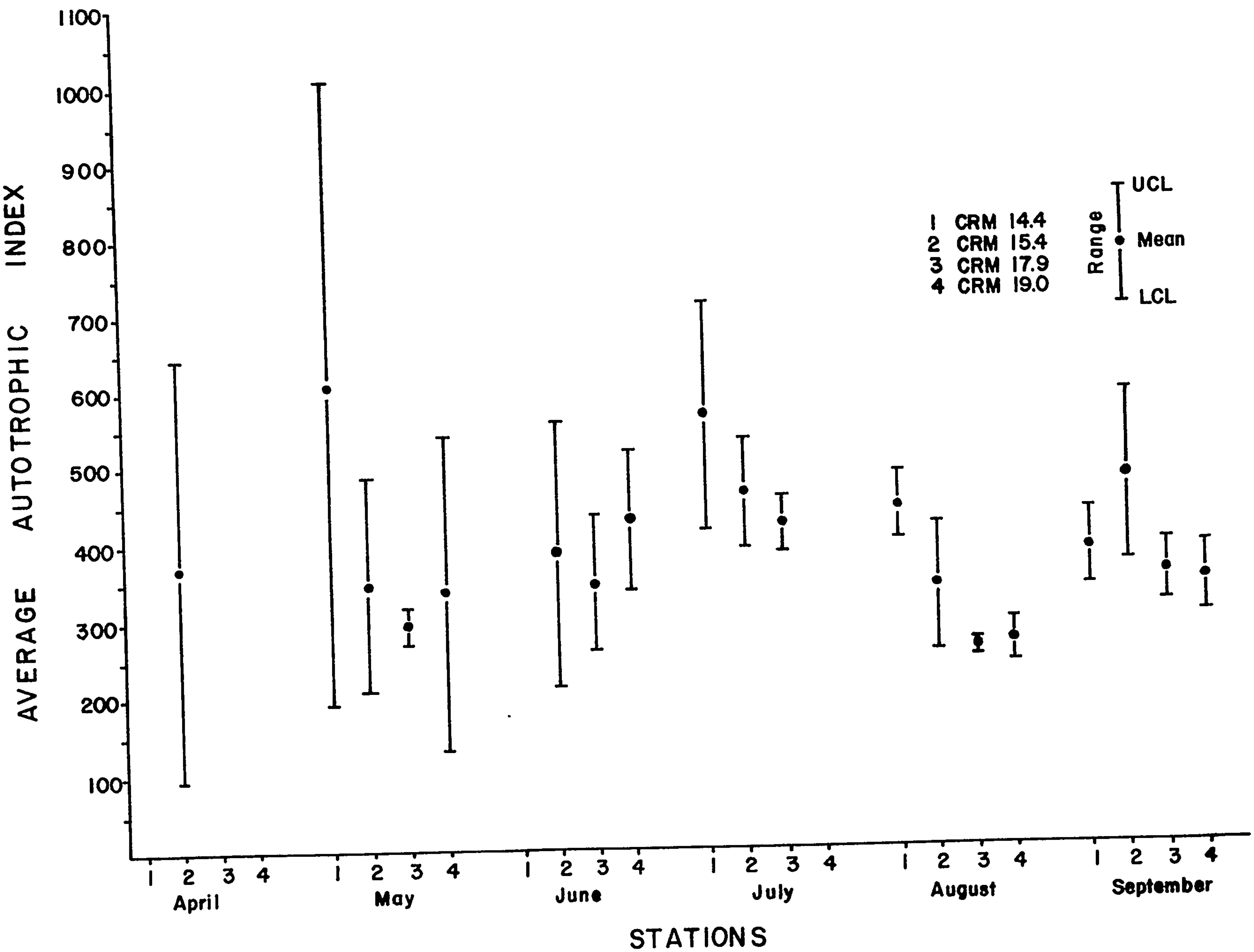

Figure IX.1. Average autotrophic index values with 95 percent confidence limits in the vicinity of proposed CRBRP, Clinch River - 1975.

Discussion and Conclusions

The data indicated that Chrysophytes (diatoms) are the dominant algal group at each of the stations. It also indicated that the genus *Achnanthes* comprises the majority of the Chrysophyta community and as such a majority of the entire periphyton community at times.

The autotrophic index data was highly variable both temporally and spatially.

IX. Literature Cited

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X. Zooplankton

X. Zooplankton

Introduction

Zooplankton constitute an extremely diverse assemblage of microscopic animals suspended in the water column. In freshwater, these organisms are dominated by planktonic species of three major groups: the rotifers, and two subclasses of the Crustacea, the Cladocera, and Copepoda (Wetzel 1975). Most zooplankton possess some swimming ability and many of the rotifers and planktonic crustaceans secrete oil globules to reduce their specific gravity to help maintain their position in the water column (Reid 1968). Zooplankton are important in maintaining the integrity of an aquatic ecosystem. Therefore it is important that we characterize this group of organisms when evaluating aquatic reaches such as portions of a river or reservoir.

Most zooplankton function as primary consumers and make energy available to higher trophic levels--i.e., larger invertebrates, fish, and other invertebrates.

Because of their weak swimming ability and susceptibility to currents, zooplankton are seldom randomly distributed throughout a body of water. Their distribution tends to be contagious, patchy, occurring in variable densities in rivers, lakes, and reservoirs. Turbulence gives rise to eddies and backflow that tend to keep zooplankton in an area of a river longer than the time it takes for the main water mass to pass the point of interest. In addition, most riverine zooplankton originate in still or slow flowing reaches, and are continually supplied to the river where they may or may not reproduce significantly (Hynes 1970).

Water flow in the Clinch River at the proposed CRBRP project is largely controlled by discharges from the Melton Hill Reservoir which is approximately 8 miles upstream. Because of the controlled discharge from Melton Hill, the Clinch River in the study area is more characteristic of a lotic rather than lentic water body. In general, those factors within a lotic (river) environment that affect the density and distribution of zooplankton can be classified under the headings of (1) water movement, (2) turbidity, (3) temperature, and (4) nutrients. The effects of water movement, turbidity, and temperature on zooplankton communities has been well studied, but the effect of nutrients is little understood because of the difficulty in demonstrating the uptake of nutrients by organisms and an immediate increase in production (Ruttner 1971). The difficulty in demonstrating nutrient effects on zooplankton is compounded by the fact that the majority of them are herbivores, the remainder predatory, and as such depend upon the nutrient uptake and production of phytoplankton. The nutrient uptake by phytoplankton and increase in their production and its relationship with zooplankton production is at best understood in general terms.

Cladocera feed more or less unselectively on materials caught by their complex legs, and thus, they would inevitably ingest some silt and small sand grains in highly turbid waters. Their capability to maintain their positions in the water column is decreased by ingesting inorganic materials (Rylov 1940). The ingested inorganic material increases their weight thus effecting their densities causing them to settle out of the water column. William (1966) stated that rotifers are also generally less common in silty waters than they are in less turbid ones.

The retention time also plays a significant role in the development of zooplankton communities. Brooks and Woodward (1956) found that the water exchange rate must be greater than 18 days for significant development to occur within a water body. Thus production in a riverine habitat would be less than in a reservoir. The flushing effect of discharges from a reservoir could increase the zooplankton populations downstream. This would depend on the number and velocity of the discharges as well as the migration patterns of the zooplankton and the time of day.

Field and Laboratory Methods

Zooplankton samples were collected from four stations located on the Clinch River. Monthly samples were collected from March 1975 to October 1975 at CRM 14.4, CRM 15.4, CRM 17.9, and CRM 19.0. Duplicate vertical hauls were made using a modified half-meter plankton net (80 u mesh) and techniques developed at TVA (Dycus and Wade 1977). The samples were preserved with formalin and returned to the laboratory.

Samples were enumerated according to procedures described in Quality Assurance Procedure No. WQEB-SS-2, Rev. 0 (TVA 1978). All zooplankton were identified to the lowest taxonomic level possible. The methods used in 1975 were the same as those outlined in the above procedural document.

Diversity index ($\bar{d}$) values were calculated using the following equations (Patten 1962):

$\bar{d}$ = $\Sigma E_1^S \, (N_i/N) \log_2 \, (N_i/N)$

s = number of species in unit area

N_i = number of individuals belonging to the species

N = total number of organisms

$\bar{d}$ = diversity per individual

Equitability values (e) were calculated in accordance with the formula (Weber 1973, and Lloyd and Gherhardi 1964).

$$e = \frac{S^1}{S}$$

S^1 = number of species expected in a sample

S = number of species in a sample

The calculation of diversity ($\bar{d}$) values and equitability values did not include immature forms with the exception of *Daphnia* immatures.

Results

Figure X.1 depicts the temporal and spatial abundance of the total zooplankton population. The population was low at all stations in March and April with a large increase in abundance in May. The large increase of rotifers in May was primarily the cause of the increase in total zooplankton during this month. The population dropped in June and increased in July, and remained fairly stable at all stations during July, August, and September, with the exception of greater abundance at river miles 14.4 in July and 17.9 in August. In October, again due to rotifers, the total zooplankton population increased approximately twofold over the months of July, August, and September. The figure also illustrates that temporal variation is much greater than spatial variation.

Total zooplankton numbers ranged from 2,523/m^3 (CRM 15.4, March 1975) to 172,093/m^3 (CRM 19.0, October 1975)(Table X.1).

A total of 95 zooplankton taxa (48 Rotifera, 28 Cladocera, and 19 Copepoda) were collected from the Clinch River within the vicinity of the proposed CRBRP project. A list of the different zooplankton species collected during 1975 are presented in Table X.2. Table X.3 provides a

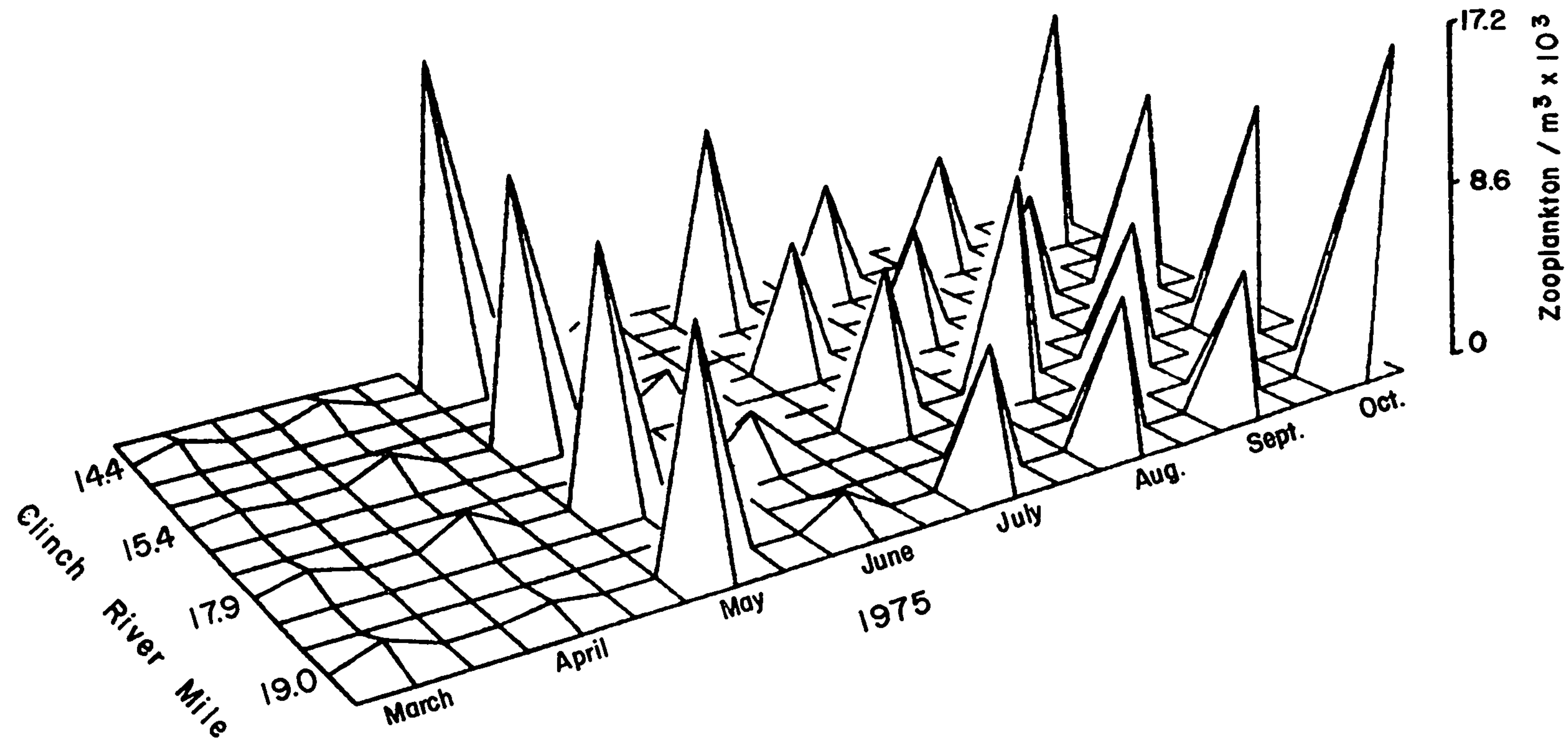

Figure X.1. Total zooplankton numbers by river mile and month in the vicinity of the proposed CRBRP - 1975.

Table X.1

Zooplankton Group Totals in the Vicinity of the CRBRP, Clinch River - 1975

(Number x 10^3)/m^3 (Average of duplicate samples)

Date	Group	Clinch River Mile 14.4	15.4	17.9	19.0
March 11	Rotifera	5.7	1.9	5.9	8.7
	Cladocera	0.9	0.4	.9	.9
	Copepoda	0.6	0.3	.9	.8
	Total	7.2	2.5	7.7	10.4
April 16	Rotifera	1.8	2.1	2.1	1.7
	Cladocera	5.4	7.1	8.5	4.1
	Copepoda	1.9	2.5	4.9	3.2
	Total	8.9	11.7	15.5	9.0
May 22	Rotifera	139.0	120.6	113.7	108.7
	Cladocera	27.1	14.4	12.8	10.7
	Copepoda	4.6	3.4	4.4	3.5
	Total	170.7	138.5	130.8	122.9
June 18	Rotifera	15.4	12.4	20.8	12.4
	Cladocera	4.6	2.5	3.0	1.9
	Copepoda	1.8	2.0	1.5	1.4
	Total	21.8	16.9	25.3	15.6
July 15	Rotifera	103.0	64.0	76.3	65.6
	Cladocera	2.2	3.1	3.4	2.9
	Copepoda	3.6	2.4	2.5	3.1
	Total	108.9	69.5	82.2	71.7
August 7	Rotifera	55.7	49.9	101.8	73.2
	Cladocera	2.2	5.0	7.4	5.5
	Copepoda	2.7	4.5	3.9	3.4
	Total	60.7	59.4	113.1	82.1
September 16	Rotifera	49.6	50.7	56.4	56.9
	Cladocera	6.2	4.6	6.9	6.9
	Copepoda	7.1	7.2	8.6	8.5
	Total	62.9	62.5	71.9	72.2
October 19	Rotifera	115.4	81.2	106.6	155.8
	Cladocera	2.8	3.6	2.5	2.9
	Copepoda	12.7	20.9	11.6	13.3
	Total	130.8	105.7	120.7	172.1

Table X.2

Taxonomic List of Zooplankton Collected in the

Vicinity of the Proposed CRBRP, Clinch River - 1975

Taxa

ROTIFERA

Asplanchna amphora Western
A. herricki de Guerne
A. priodonta Gosse
Brachionus angularis Gosse
B. bidentata Anderson
B. budapestinensis Daday
B. calyciflorus Pallos
B. caudatus Barrois and Daday
B. havanaensis Rousselet
B. quadridentatus Hermann
B. rubens Ehrenberg
Cephalodella spp.
Collotheca spp.
C. pelagica (Rousselet)
Conochiloides spp.
Conochilus unicornis Rousselet
Epiphanes macrourus Barrois and Daday
Euchlanis spp.
Filinia spp.
F. longiseta (Ehrenberg)
F. major (Colditz)
Gastropus spp.
Hexarthra spp.
H. fennica (Levander)
H. mira (Hudson)
H. mollis Bartos
Kellicottia bostoniensis (Rousselet)
K. longispina (Kellicott)
Keratella americana Carlin
K. cochlearis (Gosse)
K. crassa Ahlstrom
K. earlinae Ahlstrom
Lecane spp.
Macrochaetus spp.
Monostyla spp.
M. quadridentata Ehrenber
Platyias patulus Muller
Ploesoma hudsoni (Imhof)
P. truncatum Levander
Polyarthra spp.

Table X.2 (Continued)

Taxa
ROTIFERA
Rotaria spp.
R. neptunia (Ehrenberg)
Synchaeta spp.
S. stylata Wierzejski
Trichocerca spp.
Trichotria spp.
Contracted rotifera
CLADOCERA
Alona costata Sars
A. rectangula Sars
Bosmina longirostris (Muller)
Camptocercus rectirostris Schodler
Ceriodaphnia spp.
C. acanthina Ross
C. lacustris Birge
C. quadrangula (O. F. Muller)
Chydorus spp.
Daphnia Immature
D. galeata Sars *mendotae* Birge
D. parvula Fordyce
D. pulex Leydig
D. retrocurva Forbes
Diaphanosoma leuchtenbergianum Fischer
Ilyocryptus spp.
I. spinifer Herrick
Leptodora kindtii (Focke)
Moina spp.
M. micrura Kurz
M. minuta Hansen
Pleuroxus spp.
P. denticulatus Birge
P. hamulatus Birge
Scapholebris kingi Sars
Sida Crystallina (Muller)
COPEPODA
Calanoida
Cyclopoida
Cyclops varicans rubellus Liljeborg
C. bicuspidatus thomasi Forbes
C. vernalis Fischer

Table X.2 (Continued)

Taxa
COPEPODA
Diaptomus mississippiensis Marsh
D. pallidus Herrick
D. reighardi Marsh
D. sanguineus S. A. Forbes
Elaphoidella bidens coronata (Sars)
Ergasilus spp.
Eucyclops agilis (Koch)
Harpacticoida
Macrocyclops albidus (Jurine)
Mesocyclops edax (Forbes)
Nauplii
Nitocra lacustris (Schmankewitsch)
Paracyclops fimbriatus poppei (Rehberg)
Tropocyclops prasinus (Fisher)

Table X.3

Zooplankton Taxa and Seasonal Distribution of Taxa
Collected in Samples from the Clinch River, Proposed CRBRP - 1975

Taxa	March 1 2 3 4	April 1 2 3 4	May 1 2 3 4	June 1 2 3 4	July 1 2 3 4	August 1 2 3 4	September 1 2 3 4	October 1 2 3 4
ROTIFERA								
Asplanchna amphora	- - x x	- x x -	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x
A. herricki	- - - -	- - - -	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x
A. priodonta	x x x x	x x x x	x x x x	- - - -	- - - x	x x x -	x x x x	x x x x
Brachionus angularis	x x x x	x x - -	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x
B. bidentata	- - - -	- - - -	- - - -	- x x -	- - - -	- - - -	- - - -	- - - x
B. budapestinensis	x - x x	x x x -	- - - x	x x x x	x x x x	x x x x	x x x x	x x x x
B. calyciflorus	x x - -	- - - -	x x x x	x x x x	- - - -	- - - x	- - - -	x x x x
B. caudatus	x x x x	x - - -	- - - -	x x x x	- - x x	x x x x	- x x -	x - - -
B. havanaensis	- - x -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -
B. quadridentatus	- - - -	- - - -	- - - -	x x x -	- - - -	- x x x	- - - -	- - - -
B. rubens	- - - -	- - - -	- x x -	- - - -	- - - -	- - - -	- - - -	- - - -
Cephalodella spp.	- - - -	- - - -	x - x -	- - - x	- - - -	- x - -	x x - -	- - x x
Collotheca spp.	- - - -	- - - -	x - x -	x x x x	x x x x	x x - -	x x x x	x x x x
C. pelagica	x x x x	x x x x	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -
Conochiloides spp.	- - - -	- - x -	x x x -	x x x x	x x x x	x x x x	x x x x	- x x x
Conochilus unicornis	x - - x	- x x x	x x x x	- x x x	x x x x	x x x x	x x x x	x x x x
Epiphanes macrourus	- - - -	- - - -	x - x x	- - - -	- - - -	- - - -	- - - -	- - - -
Euchlanis spp.	x - - -	- x x x	- - - x	- - - -	- - - -	- - - -	- - x -	- - - -
Filinia spp.	- - - -	- - - -	- x - -	- - - -	x - - -	- - - x	- - x -	- - - -
F. longiseta	- - - -	- - - -	- - - x	x x x -	x x x x	x x x x	- - x -	- - - -
F. maior	x - - -	- - - -	x - x -	- - - -	- - - -	- - - -	- - - -	- - - -
Gastropus spp.	- - - -	- - - -	- - - x	x x x x	x x x x	x x x x	x x x x	x x x x
Hexarthra spp.	- - - -	- - - -	- - - -	- - - -	- - - -	x x - x	- - - -	- - - -
H. fennica	- - - -	- - - -	- - - -	- - - -	- - - -	- - - x	- - - -	- - - -
H. mira	- - - -	- - - -	- - - -	- - - -	- - - -	- - - x	- - - -	- - - -
H. mollis	- - - -	- - - -	- - - -	- x x -	- - x x	- - - -	- - - -	- - - x
Kellicottia bostoniensis	x x - -	x - - -	- - - -	- - - -	- - - -	- x x x	- - - x	- - - -
K. longispina	- - - -	- - - -	- - x -	- - - -	- - - -	- - - -	- - - -	- - - -
Keratella americana	- - - -	- - - -	- - - -	- - - -	- - - -	x - - -	- - - -	- - - -
K. cochlearis	x - x x	x - x -	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x
K. crassa	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x
K. earlinae	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x
Lecane spp.	- - - -	- - - -	- - - -	x x - -	- - - -	- - - -	x - - -	- - - -
Macrochaetus spp.	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - x
Monostyla spp.	- - - -	x - - -	- x - -	x - x x	- - x -	- x x x	- - - x	- - - x
M. quadridentata	- - - -	- - - -	- - - -	- - - -	- - - -	- - x x	- - - -	- - - -
Platyias patulus	- - - -	- - - -	- - - -	x - - -	- - - -	- - - -	x - - -	- - - -
Ploesoma hudsoni	- - - -	- - - -	x - - -	- - - -	- - - -	- - - -	- x x x	- - - -
P. truncatum	- - - -	- x x -	x - x x	x x x x	x x x x	x x x x	x x x x	x x x x
Polyarthra spp.	x x x x	x x - -	x x x x	x x x x	x x x x	x - x x	x x x x	x x x x
Rotaria spp.	- - - -	- - - -	- - - -	- - - x	- - - -	x - - -	- - - -	- - x -
R. neptunia	x x x x	- - x -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -
Synchaeta spp.	- - - -	- - - -	- x - x	- - - -	- - - -	x x x x	x x x x	- x - -
S. stylata	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x	- - - -	x x x x
Trichocerca spp.	- - - -	- - - -	x - x -	- - x x	x x x x	x x x x	x x x x	x - x x
Trichotria spp.	x x - -	- - - -	- - - x	- x - -	- - - -	- - - -	- - - -	- - - -
Contracted rotifera	- - - -	- - - -	- - - -	- - - -	- - - -	- x x -	x x - -	- - - -

Table X.3 (Continued)

	March	April	May	June	July	August	September	October
	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
CLADOCERA								
Alona costata	- - - -	- - - -	- - - -	x x x -	- - - -	- - - -	- - - -	- - - -
A. rectangula	- - - -	- - - -	- - - -	- - - x	- x - -	- - - -	- - - -	- - - -
Bosmina longirostris	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x
Camptocercus rectirostris	- - - -	- - - -	- - - -	- - - -	- - x -	x - - -	x - - -	- - - -
Ceriodaphnia spp.	- - - -	- - - -	- - - -	- - - -	x x x x	- - x x	- - - -	- - - -
C. acanthina	- - - -	- - - -	- - - -	- - - -	- - - -	x - - -	- - - -	- - - -
C. lacustris	- - - -	- - - -	- - - x	x x x x	x x x x	x x x x	x x x x	x x x x
C. quadrangula	- - - -	- - - -	- - - -	- - - -	- - x -	x x x x	- - - -	- - - -
Chydorus spp.	- - - -	x - - x	x x x x	x x x x	x - x -	- x x -	- - - -	- - - -
Daphnia Imm.	- - - x	- - - -	x x x x	x x x x	x x x x	x x x x	x x x x	x x - -
D. galeata mendotae	- - - -	- - - -	- x - -	- - - -	- - - -	- - - -	- - - -	- - x -
D. parvula	- - x x	x x x -	x - x x	- - - -	- - x x	x x x x	- - - -	- x - -
D. pulex	- - - -	- - - -	- - - -	x x x x	- - - -	- - - -	- - - -	- - - -
D. retrocurva	x - - -	- - - -	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x
Diaphanosoma leuchtenbergianum	- - - -	- - - -	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x
Ilyocryptus spp.	- - - -	- - - -	- - - -	- - - -	- x - -	x x - -	- - - -	- - - -
I. spinifer	- - - -	- - - -	- - - -	- - - -	- x - -	- - - -	x x x -	- - - x
Leptodora kindtii	- - - -	- - - -	x x x x	x x x x	x x x x	x x x x	x - x x	x x x x
Moina spp.	- - - -	- - - -	- - - -	- - - -	- x x -	x x x x	- - - -	- - - -
M. micrura	- - - -	- - - -	- - - -	- - - -	x x x x	x x x x	- - - -	- - - -
M. minuta	- - - -	- - - -	- - - -	- - - -	- - - -	x - - -	- - - -	- - - -
Pleuroxus spp.	- - - -	- - - -	- - - -	- - - -	- x - -	- - - -	- - - -	- - - -
P. denticulatus	- - - -	- - - -	- - - -	- x - -	- - - -	- - - -	- - - -	- - - -
P. hamulatus	- - - -	- - - -	- - - -	- - - -	- - - -	x x x x	- - - -	- - - -
Scapholebris kingi	- - - -	- - - -	x x - -	- - - -	- - - -	- - x x	- - - -	- - - -
Sida crystallina	- - - -	- - - -	- - - x	- - - -	x x x x	x x - -	x x - x	- - x x
COPEPODA								
Calanoida	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x
Cyclopoida	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x
Cyclops varicans rubellus	- - - -	- - - -	x x x x	- - - -	- - - -	- x x -	- x - -	- - - -
C. bicuspidatus thomasi	x x x x	x x x x	x x x x	x x x x	- - - -	x - x x	- - - -	- - - -
C. vernalis	- - - -	x x x x	- x x x	x x x x	x x x x	x x x x	x x x x	x x x x
Diaptomus mississippiensis	- - - -	- - - -	- - - -	- x - -	- - - -	- - - -	- - - -	- - - -
D. pallidus	x x x x	x x x x	x x x x	x x - x	x - x x	x x x x	x x x x	x x x x
D. reighardi	- - - -	- - - -	- - - -	x - - -	- - - -	- x - x	- x x -	- - x -
D. sanguineus	- - - -	- x x x	x x x x	- - - x	- - - -	- - - -	- - - -	- - - -
Elaphoidella bidens coronata	- - - -	- - - -	- - - -	- - - -	- x - -	- x - x	- - - x	- - - -
Ergasilus spp.	- - - -	- - - -	- - - -	- - - -	- - - -	- - x -	- - x -	x - - -
Eucyclops agilis	- - - -	- - - -	- - - -	- - - -	- - - x	x - x x	- - - -	- - - -
Harpacticoida	- - - -	- - - -	- - - -	- - - x	x - - -	- - - -	- - - -	x - - -
Macrocyclops albidus	- - - -	- - - -	- x - -	- - - -	- - - -	- - - -	- - - -	- - - -
Mesocyclops edax	- - - -	x x x -	x x x -	x x x x	x x x x	x x x x	x x x x	x x x x
Nauplii	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x	x x x x
Nitrocra lacustris	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	x - - -	- - - -
Paracyclops fimbriatus poppei	- - - x	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -
Tropocyclops prasinus	- - - -	- - - -	- x - -	- - - -	- - - -	- - - x	- x - x	- x x x

Note: 1 - CRM 14.4
2 - CRM 15.4
3 - CRM 17.9
4 - CRM 19.0
X = Presence of Taxon

listing of the temporal and spatial occurrence of the different zooplankton taxa collected. Table X.4 lists the percentage composition of each major zooplankton group. The Rotifera were the dominant organisms in abundance at all stations from March 1975 to October 1975 with the exception of April when the Cladocera were dominant. The Rotifera ranged from 1704/m^3 (CRM 19.0, April 1975) to 155,875/m^3 (CRM 19.0, October 1975) (Table X.1). The Rotifera comprised up to 94.6 percent population in July 1975 (CRM 14.4) and a low of 13.6 percent in March (CRM 17.9) (Table X.4). The predominant Rotiferan taxa based on percent (84 to 100 percent) occurrence were *Asplanchna amorpha*, *Branchionus angularis*, *B. budapestinensis*, *Conochilus unicornis*, *Keratella cochlearis*, *K. crassa* Ahlstrom, *K. earlinae*, *Polyarthra* spp., and *Synchaeta stylata*.

However, based on percent abundance, *Asplanchna herricki*, *C. unicornis*, *Polyarthra* spp., *S. stylata*, and *K. earlinae* were the dominant organisms. Numbers per cubic meter for individual zooplankton taxa are listed in Appendix B, Table B.2.1. The total rotifer population was least abundant in April and most abundant in May and October. The five taxa previously mentioned as being most abundant comprised 90.6 percent of the rotifer population and 73.8 percent of the total zooplankton population in May at CRM 14.4. They comprised 85, 78, and 82.1 percent of the rotifer population at river miles 15.4, 17.9, and 19.0, respectively, and 74.1, 68.0, and 72.6 percent of the total zooplankton population at the respective river miles in May. In October, three taxa, *Branchionum angularis*, *Keratella earlinae*, and *Polyarthra* spp., comprised 84.2, 86.7, 87.2, and 81.4 percent of the rotifer population; and 74.3, 66.7, 77.0, and 73.8 percent of the total zooplankton population at river miles 14.4, 15.4, 17.9, and 19.0, respectively.

Table X.4

Zooplankton Percentage Composition by Group, in the Vicinity of the Proposed CRBRP, Clinch River - 1975

Date	Group	Clinch River Mile 14.4	15.4	17.9	19.0
March 11	Rotifera	78.8	73.3	76.6	83.5
	Cladocera	12.4	15.3	12.0	8.5
	Copepoda	8.8	11.4	11.4	8.0
April 16	Rotifera	19.8	18.5	13.6	19.0
	Cladocera	60.2	60.5	54.8	45.2
	Copepoda	7.0	21.0	31.7	35.8
May 22	Rotifera	81.4	87.1	86.9	88.5
	Cladocera	15.9	10.4	9.7	8.7
	Copepoda	2.7	2.5	3.4	2.8
June 18	Rotifera	70.8	73.3	82.1	79.3
	Cladocera	21.0	14.9	11.9	12.0
	Copepoda	8.2	11.8	6.0	8.7
July 15	Rotifera	94.6	92.2	92.7	91.5
	Cladocera	2.0	4.4	4.2	4.1
	Copepoda	3.3	3.4	3.1	4.4
August 7	Rotifera	91.8	84.1	90.0	89.2
	Cladocera	3.7	8.4	6.6	6.7
	Copepoda	4.5	7.5	3.4	4.1
September 16	Rotifera	78.9	81.2	78.4	78.7
	Cladocera	9.9	7.3	9.6	9.6
	Copepoda	11.2	11.5	12.0	11.7
October 19	Rotifera	88.2	76.9	88.3	90.6
	Cladocera	2.1	3.4	2.1	1.7
	Copepoda	9.7	19.7	9.6	7.7

Note: These percentages are calculated from actual numbers and not significant numbers in Table X.1.

The Cladocera were the dominant zooplankton group at all stations on April 16, 1975. However, the largest standing crop of Cladocera was collected on May 22, 1975 (Table X.1). The numbers/m^3 ranged from 386 (CRM 15.4, March 1975) to 27,082 (CRM 14.4, May 1975). The percentage composition of Cladocera ranged from 2.0 percent (CRM 14.4; July 1975) to 60.5 percent (CRM 15.4; April 1975). The most dominant cladoceran throughout the year was Boxmina longirostris (Muller). In April when cladocerans were the dominant group, Boxmina longirostris comprised 99.7, 99.5, 99.7, and 99.6 percent of the cladoceran population at CRM 14.4, CRM 15.4, CRM 17.9, and CRM 19.0, respectively.

Nauplii, Calanoid immatures, and Cyclopoid immatures were the dominant copepods collected. Copepod numbers ranged from 287/m^2 (CRM 15.4, March 1975) to 20,824/m^2 on October 19 at the same river mile. Percent composition varied from 2.5 percent (CRM 15.4; May 1975) to 19.7 percent (CRM 15.4, October 1975). At no time were the copepods the dominant zooplankton group.

With respect to the difference in the number of taxa collected at each station, there was little difference from station to station in the same month, but there were greater differences from month to month (Table X.5).

The values of $\bar{d}$ are a reflection of both the number of taxa and the number of individuals contributed by each of these taxa to the total number of organisms. The diversity index ranged from 1.38 (CRM 17.9, April 1975) to 3.764 in June 1975 at the same river mile (Table X.5). Variation between stations within a given month was not as great as between the different collection dates.

Table X.5

Zooplankton Community Diversities, Equibilities, and Number of Taxa in the Vicinity of the Proposed CRBRP, Clinch River - 1975

Survey Date		Clinch River Mile 14.4	15.4	17.9	19.0
March 11	# taxa	21	15	17	19
	$\bar{d}$	2.429	2.701	2.337	2.400
	e	0.35	0.60	0.40	0.38
April 16	# taxa	19	19	20	13
	$\bar{d}$	1.516	1.460	1.379	1.697
	e	0.19	0.18	0.16	0.32
May 22	# taxa	32	32	33	33
	$\bar{d}$	2.957	3.051	3.100	3.021
	e	0.34	0.37	0.37	0.35
June 18	# taxa	34	37	34	34
	$\bar{d}$	3.327	3.699	3.764	3.682
	e	0.42	0.51	0.58	0.55
July 15	# taxa	31	33	36	33
	$\bar{d}$	3.608	3.143	3.452	3.114
	e	0.57	0.38	0.44	0.37
August 7	# taxa	43	43	42	47
	$\bar{d}$	3.073	3.547	2.855	3.145
	e	0.28	0.39	0.24	0.27
September 16	# taxa	32	32	33	31
	$\bar{d}$	3.590	3.565	3.420	3.362
	e	0.54	0.53	0.46	0.47
October 19	# taxa	28	28	31	33
	$\bar{d}$	2.482	3.072	2.442	2.856
	e	0.28	0.43	0.24	0.31

$\bar{d}$ = diversity index
e = equitability

Discussion

The total zooplankton abundance at the proposed CRBRP site is much greater than that found in the vicinity of the Bull Run Steam Plant (TVA 1976), which is located at approximately CRM 48.0. Bull Run, unlike the CRBRP sites, is located upstream from Melton Hill Reservoir. Melton Hill provides the quiet, slow moving waters that are conducive to zooplankton reproduction. As such, Melton Hill acts as a reserve pool of organisms for the river downstream.

Large numbers of zooplankton are added to the downstream population from Melton Hill during discharges from the penstocks and navigation locks. Thus a greater number of zooplankton than at Bull Run.

The rotifer population increased at both Bull Run and the CRBRP stations during May 1975 indicating the environmental conditions were conducive to rotifer production on the Clinch River in May. However, the increase of rotifers in October did not occur at Bull Run. Rotifers dominated the zooplankton population at both sites during 1975.

Bosmina longirostris was the dominant cladoceran at both Bull Run and CRBRP during 1975, thus indicating that the Clinch River provides good, if not optimum, conditions for this species.

Diversities were higher at all four stations on March 11, 1975, than on April 16, 1975, even though the total number of taxa at each station were similar. Individuals were more evenly distributed among the taxa on March 11, 1975, than on April 16, 1975, thus the higher diversities. The increase in $\bar{d}$ values in May was due to the increase in the number of taxa and the increase of individuals within these taxa. However, the overall population decreased in June, but the diversity values increased. As indicated by the (e) values the distribution of individuals was more equal among taxa on June 18, 1975, than on May 22, 1975. Thus the increase in $\bar{d}$ even though the number of zooplankton in May 1975 was much greater than in June. This same effect occurred in October 1975. The total population in October 1975 was primarily due to three species of rotifera. Thus an unequal distribution of individuals among the taxa is reflected in the decrease of the diversity index, $\bar{d}$.

Conclusions

Rotifers were the predominant zooplankton at all stations with the exception of April 1975, when the Cladocera were the dominant group.

Seasonal effects on rotifers are quite dramatic with large abundances occurring in May 1975 and October 1975 for some species and May 1975, August 1975, and September 1975 for others. Five species were primarily responsible for rotifer abundance throughout the year.

One species of Cladocera, Bosmina longirostris, was found on all sampling dates and was the dominant Cladoceran at most stations throughout the year.

Diversity indices did indicate seasonal changes in number of taxa and abundance within those taxa.

Large numbers of zooplankton are added to the downstream population from Melton Hill reservoir during discharges from the penstocks and navigation locks.

There were no dramatic differences between the four stations with respect to the zooplankton population. The predominance of five rotifer species and one cladoceran species should provide a good basis on which to determine effects of construction and operation of a plant. Any major shifts in abundance of these species or replacement of them by others would provide a key to determine possible environmental changes. A shift from a predominant rotifer population to either a cladoceran or copepod population would also be an excellent criteria to assess any effects, natural or manmade.

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XI. Benthic Macroinvertebrates

XI. Benthic Macroinvertebrates

Introduction

All organisms living in or upon the bottom substrates of a body of water are collectively termed benthos (Reid 1961). Benthos, as discussed in this section, has been limited to aquatic macroinvertebrates that are retained on a standard No. 40 mesh (340 m openings) sieve and live at least part of their life cycles within or upon available substrates in a body of water. The prevalent benthic macroinvetebrate assemblage in the Clinch River is comprised of freshwater clams, aquatic insects (chironomid midges, mayflies, caddisflies, etc.), and aquatic worms. The life history of some of these individuals is long and spans more than a year (clams), while others vary from a few weeks (chironomid midges) with several generations per year. Hynes (1970) reports that the ecology of stream insects is still largely exploratory and descriptive, and limnologists are beginning to understand some of the reasons for particular distributions in relation to substratum, temperature, seasonal cycles, etc.

The availability of food, nature of the sediments, and flow patterns generally constitute the primary factors determining benthic macroinvertebrate microdistribution (Cummins 1975). Cummins also states that food is the ultimate determinant of macroinvertebrate distribution and abundance in nonperturbated waters.

The majority of macroinvertebrates are nonselective feeders (Hynes 1970), taking in a wide range of food substances of acceptable particle dimensions. Macroinvertebrates primarily comprise four fundamental groups (Cummins 1975):

1. grazers and scrapers--herbivores feeding on attached algae;
2. shredders--large particle feeding detritivores;
3. collectors--both suspension (filter) and deposit (surface) fine particle feeding detritivores; and
4. predators--carnivores.

The general macroinvertebrate functional categories--grazers, shredders, collectors, and predators--serve as interrelated, carbon dioxide producing, temporary storage bins for organic compounds. Thus, the role of macroinvertebrates in the overall structure and function of a river ecosystem is the conversion of reduced carbon compounds derived primarily from the surrounding land (allochthonous material), supplemented by instream carbon fixation (autochthonous material), into temporary storage in their own tissues and into carbon dioxide (Cummins 1973).

Benthic macroinvertebrates serve as a source of food for fish and other higher aquatic life. These animals are often studied because of the dependency on the bottom fauna of fish. If the bottom fauna are destroyed, the fish will ultimately suffer. However, there are several other reasons why bottom fauna are studied. First, many species are sensitive to pollution and respond quickly to it. Second, many have a relatively long and usually complex life cycle of a year or more, and their presence or absence helps describe environmental conditions over a period of time. This is further enhanced by the fact that many have an attached, or sessile, mode of life and are not subject to rapid migrations, they serve as natural monitors of water quality.

Field and Laboratory Methods

The benthic macroinvertebrate populations in the vicinity of the proposed Clinch River Breeder Reactor Project were sampled using artificial substrate samplers and a Ponar grab sampler. Sampling stations were located at CRM 14.4, CRM 15.4, CRM 17.9, and CRM 19.0. Ten Ponar grab samples were collected monthly at each station from March 1975 to September 1975, and seasonally (March, May, July, September) in 1976 and 1977. Artificial substrate samplers were used monthly from April 1975 until November 1975 and seasonally (May, July, September, November) in 1976 and 1977.

Barbecue baskets filled with stones served as artificial substrates. Each basket had a volume of 7675.2 cm^3, and was allowed to be colonized for two months before retrieval. The Ponar grab samples and the artificial substrate samples were washed in the field on a standard No. 40 mesh (340 μm opening) wash screen, placed in a plastic bag, tagged, and preserved with 10 percent Formalin. The samples were then returned to the Water Quality and Ecology Branch laboratory for processing.

The benthic fauna was identified and enumerated to the lowest taxonomic level possible. The results were recorded as mean number of organisms per m^2 for Ponar samples and mean number per substrate sampler for artificial substrates. The benthic organisms were separated into molluscan and nonmolluscan categories and wet weight biomass was obtained for each group. The organisms were blot dried with absorbent paper and then weighed on a Mettler P1200N electrical balance. Biomass was recorded as gm per m^2 for Ponar grab samples and mg per artificial substrate for artificial substrates.

Diversity index ($\bar{d}$) values (Patten, 1962) and equitability values (e) (Weber, 1973; Lloyd and Gherlardi, 1964) were calculated for the data collected (see Chapter X for a description of these calculations).

Results

Ponar Grab Samples

A total of 25 benthic macroinvertebrate taxa were collected from March 1975 to September 1977 (Table XI.1). Insects were the most diverse group (17 taxa) with the freshwater clams having two taxa and the flatworms three. There was one taxa represented in the following groups: aquatic worms, mussels, scuds, and bryozoans. Five taxa, *Limnodrilus claparedeianus*, *Chironomus* sp., *Dicrotendipes* sp., *Cyrnellus fraternus*, and *Corbicula manilensis*, were collected during each year of the study. However, *Corbicula manilensis* was collected more frequently than any other taxa during 1975, 1976, and 1977. (Tables XI.2, XI.3, and XI.4.) The percent occurrence for *Corbicula manilensis* was 91, 81, and 75 percent for 1975, 1976, and 1977, respectively. The percent occurrence for one other taxa (Dicrotendipes) was 25 percent in 1975 with the other taxa being sporadic and infrequent in their occurrence during the study period. The abundance of *Corbicula manilensis* ranged from $0.0/m^2$ at several stations to $141.3/m^2$ at CRM 19.0 in September 1976 (Appendix B, Tables B.3.1, B.3.2, and B.3.3). Total benthic macroinvertebrate standing crop was low during the study period (Table XI.5) with a range of $0.0/m^2$ at several stations to $152.2/m^2$ at CRM 19.0 in September 1976.

Diversity index ($\bar{d}$) values (Table XI.6) are indicative of the number of taxa collected at each station and the numbers within each taxa. Diversities ranged from 0.0 (indicating the presence of only one taxa) at several stations to 2.650 at CRM 14.4 in September 1977.

Table XI.1

Benthic Macroinvertebrate Fauna Collected in the Vicinity

of the Proposed CRBRP, Clinch River - 1975, 1976, 1977

(Ponar Grab Samples)

	1975	1976	1977
Annelida			
Clitellata			
Tubificidae			
Limnodrilus claparedeianus Ratzel	x	x	x
Arthropoda			
Crustacea			
Amphipoda			
Cragonyx	-	-	x
Insecta			
Diptera			
Chaoboridae (Non-biting mosquitoes)			
Chaoborus	x	x	-
Chironomidae			
Chironomus	x	x	x
C. tentans Fabricus	-	x	-
Dicrotendipes	x	x	x
Eriocera	-	-	x
Parachironomus	-	x	-
Pentaneura	x	-	-
Procladius	-	-	x
Psectrocladius	-	-	x
Rheotanytarsus	-	-	x
Xenochironomus	-	-	x
Ephemeroptera			
Hexagenia bilineata (Say)	-	x	-
Caenis	-	-	x
Hemipfera			
Corixidae	-	-	x
Megaloptera			
Sialis	-	x	-
Trichoptera			
Leptoceridae			x
Psychomysidae			
Cyrnellus fraternus (Banks)	x	x	x
Bryozoa	x	-	-
Mollusca			
Bivalvia			
Heterodonta			
Cyrenidae			
Corbicula manilensis	x	x	x
Sphaeridae			
Sphaerium	-	x	-
Unionidae			
Quadrula postulosa	-	-	x

Table XI.1
(Continued)

	1975	1976	1977
Platyhelminthes			
Turbellaria			
Tricladia			
Planarridae	x	-	-
Cura foremanii (Girard)	-	x	x
Dugesia	-	-	x

x = Taxa collected
- = Taxa not collected

Table XI.2

Temporal and Spatial Distribution of the Benthic Macroinvertebrates

Collected in the Vicinity of the Proposed CRBRP, Clinch River - 1975

(Ponar Grab Samples)

	March				April				May				June				July				August				September				October			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Bryozoa	x	x	x		x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clitellata																																
Limnodrilus claparedianus	-	-	-	-	-	-	-	-	-	-	x	x	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	x	x	-	-	-
Diptera																																
Chaoborus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-
Chironomus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	x	x	x	x	x	-	-	-
Dicrotendipes	x	-	-	-	x	-	-	-	x	-	x	x	x	-	x	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pentaneura	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-
Tanytarsus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-
Heterodonata																																
Corbicula manilensis	x	x	x	x	x	x	x	x	x	x	x	-	x	-	x	x	-	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Trichoptera																																
Cyrnellus fraternus	x	-	x	-	x	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	x	-	-	-	-	-	-
Turbellaria																																
Planariidae	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

1 - CRM 14.4
2 - CRM 15.4
3 - CRM 17.9
4 - CRM 19.0
x = Presence of taxa
- = Absence of taxa
Note: No organisms present in Ponar grab samples - June, CRM

Table XI.3

Temporal and Spatial Distributions of the Benthic Macroinvertebrates Collected in the Vicinity of the Proposed CRBRP, Clinch River - 1976

(Ponar Grab Samples)

	March				May				July				September			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Clitellata																
Limnodrilus claparedianus	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	x
Diptera																
Chaoborus	-	-	-	-	-	-	-	-	x	x	x	x	-	-	-	-
Chironomus	-	-	-	-	x	-	-	-	-	-	-	x	-	-	x	-
Chironomus tentans	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-
Dicrotendipes	-	-	-	-	x	-	-	-	-	-	-	-	x	-	-	-
Parachironomus	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
Ephemeroptera																
Hexagenia bilineata	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
Heterodonta																
Corbicula manilensis	x	-	x	-	x	x	-	x	x	x	x	x	x	x	x	x
Sphaerium	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
Megaloptera																
Sialis	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-
Trichoptera																
Cyrnellus fraternus	-	-	-	-	-	-	-	-	-	-	-	-	x	-	x	-
Turbellaria																
Cura foremanii	-	-	-	-	-	-	-	-	-	-	-	-	x	-	x	x

1 - CRM 14.4
2 - CRM 15.4
3 - CRM 17.9
4 - CRM 19.0

Note: No organisms present in Ponar grab samples at CRM 15.4 in March, CRM 17.9 in May, and at CRM 19.0 in March.

Table XI.4

Temporal and Spatial Distributions of the Benthic Macroinvertebrates Collected in the Vicinity of the Proposed CRBRP, Clinch River - 1977

(Ponar Grab Samples)

	March				May				July				September			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Amphipoda																
Crangonyx	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-
Clitellata																
Limnodrilus	-	-	-	-	-	-	-	-	-	-	-	-	-		x	x
Diptera																
Chironomus	-	-	-	-	-	-	-	-	x	-	-	-	-		-	-
Dicrotendipes	-	-	-	-	-	-	-	-	-	-	-	-	x		x	-
Eriocera	-	-	-	x	-	-	-	-	-	-	-	-	-		-	-
Procladius	-	-	-	-	-	-	-	-	-	-	-	-	x		-	-
Psectrocladius	-	-	-	-	-	-	-	-	-	-	-	-	x		-	-
Rheotanytarsus	-	-	-	-	-	-	-	-	-	-	-	-	x		-	-
Tanytarsus	x	-	-	-	-	-	-	-	-	-	-	-	-		-	-
Xenochironomus	x	-	-	-	-	-	-	-	-	-	-	-	-		-	-
Ephemeroptera																
Caenis	-	-	-	-	-	-	-	-	-	-	-	-	x		-	-
Hemiptera																
Corixidae	-	-	-	-	-	-	-	-	-	-	-	-	x		-	-
Heterodonta																
Corbicula manilensis	-	x	x	x	x	x	-	x	x	-	x	x	x		x	x
Quadrula postulosa	-	-	-	-	-	-	-	x	-	-	-	-	-		-	-
Trichoptera																
Cyrnellus fraternus	-	-	-	-	-	-	-	-	-	-	-	-	x		x	-
Leptoceridae	-	-	-	-	-	-	-	-	-	-	-	-	-		x	-
Turbellaria																
Cura foremanii	-	-	x	-	-	-	-	-	-	-	x	-	-		-	-
Dugesia	-	-	-	-	-	-	-	-	-	-	-	-	x		-	-

1 - CRM 14.4
2 - CRM 15.4
3 - CRM 17.9
4 - CRM 19.0

Note: No organisms present in the Ponar grab samples at CRM 15.4 in July and at CRM 17.9 in May.

x = Presence of Taxa
- = Absence of Taxa
Blank = Samples were missing

Table XI.5

Macrobenthic Invertebrate Standing Crop in the Vicinity of the Proposed CRBRP, Clinch River - 1975, 1976, 1977

(Mean Number/M^2)

		Clinch River Mile			
Year	Month	14.4	15.4	17.9	19.0
1975	March	37.9	16.3	45.2	3.6
	April	81.6	5.4	3.6	5.4
	May	50.6	1.8	28.9	29.0
	June	18.0	0.0	9.0	30.7
	July	5.4	1.8	1.8	3.6
	August	14.4	1.8	1.8	5.4
	September	21.8	18.1	59.7	50.7
	October	25.3	14.5	1.8	5.4
1976	March	1.8	0.0	3.6	0.0
	May	21.8	1.8	0.0	7.2
	July	9.0	18.0	41.5	21.7
	September	27.1	9.0	39.8	152.2
1977	March	5.4	7.2	10.8	7.2
	May	10.8	5.4	0.0	3.6
	July	16.2	0.0	25.3	23.6
	September	48.7	*	19.9	65.2

*September 1977 samples at CRM 15.4 missing.

Table XI.6

Benthic Macroinvertebrate Community Diversity Indices ($\bar{d}$) and Equitability (e) Values in the Vicinity of the Proposed CRBRP, Clinch River - 1975, 1976, 1977

(Ponar Grab Samples)

Year	Month	Clinch River Mile 14.4		15.4		17.9		19.0	
		$\bar{d}$	e	$\bar{d}$	e	$\bar{d}$	e	$\bar{d}$	e
1975	March	1.933	1.25	0.992	1.20	0.638	0.57	1.000	1.20
	April	1.497	0.89	0.000	0.00	0.000	0.00	0.000	0.00
	May	1.222	0.93	0.000	0.00	1.271	0.98	0.336	0.65
	June	1.000	1.20	*	*	0.722	0.90	1.331	1.07
	July	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00
	August	0.544	0.80	0.000	0.00	0.000	0.00	0.000	0.00
	Sept.	0.812	0.67	1.292	1.00	1.006	0.48	1.402	0.85
	Oct.	1.530	1.23	0.000	0.00	0.000	0.00	0.000	0.00
1976	March	0.000	0.00	*	*	0.000	0.00	*	*
	May	0.646	0.88	0.000	0.00	*	*	1.500	1.20
	July	1.922	1.25	1.522	1.20	0.677	0.60	0.814	0.63
	Sept.	2.173	1.20	0.000	0.00	1.453	0.88	0.418	0.48
1977	March	0.918	1.10	0.000	0.00	0.650	0.88	0.811	1.00
	May	0.000	0.00	0.000	0.00	*	*	1.000	1.20
	July	0.918	1.10	*	*	0.748	0.93	0.389	0.70
	Sept.	2.650	0.97	*	+	1.968	1.04	0.182	0.60

+ September 1977 samples missing at CRM 15.4
* No organisms present in the Ponar grab samples.

Note: A diversity index value ($\bar{d}$) of 0.000 indicates the presence of only one taxa in the samples collected.

Artificial Substate Samples

Artificial substrate samples were collected from all stations in 1975 with the exceptions of CRM 14.4 in April, May, and September; CRM 15.4 in July; and CRM 19.0 in June. In 1976 the only station not collected was CRM 19.0 in July. Because of the artificial substrate samplers not being retrieved or not being covered by water, samples were collected only 5 of a possible 16 times in 1977. Samples were collected at CRM 14.4 in September; CRM 17.9 in July and September; and CRM 19.0 in September and November.

A total of 57 taxa were collected during 1975, 1976, and 1977 (Table XI.7) with the following taxa were collected every year: Chironomus sp., Cyrnellus fraternus (Banks), Corbicula manilensis Phillippi, and Cura foremanii (Girard).

The spatial and temporal distribution of the taxa for 1975, 1976, and 1977 are listed in Tables XI.8, XI.9, and XI.10, respectively. The prevalent species collected with artificial substrates in 1975, 1976, and 1977 are listed in Table XI.11. The percent occurrences are based upon an organism being collected a possible 27 times in 1975, 15 in 1976, and 5 in 1977.

In 1975 the prevalent taxa include an Ephemeroptera, Stenonema (70.4 percent); two genera of Chironomids, Chironomus (63.9 percent) and Dicrotendipes (59.3); a freshwater clam, Corbicula manilensis (59.3 percent); and one Trichoptera, Cyrnellus fraternus (55.6 percent). The percent composition of the above species was somewhat similar in 1976, with Chironomus being 80 percent, an increase of 16 percent.

Table XI.12 lists an estimate of the macrobenthic standing crop recovered from artificial substrates. The estimates are given with and without Sida crystallina included in the data because it is a littoral

Table XI.7

Benthic Macroinvertebrate Fauna Collected in the Vicinity of the Proposed CRBRP, Clinch River - 1975, 1976, 1977

(Artificial Substrates)

	1975	1976	1977
Annelida			
Clitellata (Oligochaeta)			
Haplotaxida			
Tubificidae	-	-	x
Lumbriculida			
Lumbriculidae	-	-	x
Tubificidae			
Branchiura sowerbyi Beddard	x	x	-
Limnodrilus	x	x	-
Limnodrilus claparedianus Ratzel	-	x	-
Hirudinea (leeches)	x	-	-
Arthropoda			
Crustacea			
Amphipoda			
Crangonyx	x	-	-
Gammarus	x	-	-
Cladocera			
Sida crystallina Muller*	x	-	-
Decapoda			
Cambarus	x	-	-
Orconectes	x	-	-
Isopoda			
Lirceus	x	-	-
Insecta			
Coleoptera			
Dubiraphia	-	-	x
Diptera			
Chironomidae	-	-	x
Ablabesmyia	x	-	x
Chironomus	x	x	x
C. tentans	x	-	-
Cricotopus	-	-	x
Cryptochironomus	-	x	x
Dicrotendipes	x	x	x
Endochironomus	-	-	x
Eukiefferiella	-	-	x
Glyptotendipes	-	-	x
Parachironomus	-	x	x
Pentaneura	x	x	-
Polypedilum	-	-	x
Procladius	x	-	-
Psectrocladius	-	-	x
Rheotanytarsus	-	-	x
Xenochironomus	x	-	x

Table XI.7
(Continued)

	1975	1976	1977
Simulidae	-	-	x
Ephemeroptera			
Caenis	x	-	-
C. simulans	-	x	-
Hexagenia bilineata (Say)	x	-	-
Stenocron	x	-	x
Stenonema	x	x	-
S. tripuncatum	-	x	-
Tricorythodes	-	-	x
Megaloptera			
Sialis	-	-	x
Odonata			
Argia	x	-	x
Macromia	x	-	-
Trichoptera			
Agraylea	-	-	x
Cheumatopsyche	x	-	-
Cyrnellus fraternus (Banks)	x	x	x
Hydroptila	-	-	x
Hydrosyche	-	x	-
Neureclipsis	-	x	x
Polycentropus	-	-	x
Bryozoa	x	-	-
Coelenterata			
Athecata			
Hydra americana (Hyman)	-	x	-
Mollusca			
Bivalvia			
Heterodontida			
Corbicula manilensis Phillippi	x	x	x
Sphaerium	x	-	x
Gastropoda			
Mesogastropoda			
Pleurocera canaliculatum (Say)	-	-	x
Platyhelminthes			
Turbellaria			
Tricladida			
Planariidae			
Cura foremanii (Girard)	x	x	x
Dugesia tigrina (Girard)	-	-	x

* - Sida crystallina is not a true benthic organism, but was found in large numbers on some of the artificial substrates.

x = Taxa collected

- = Taxa not collected.

Table XI.8

Temporal and Spatial Distributions of Benthic Macroinvertebrates in the Vicinity of the Proposed CRBRP, Clinch River - 1975
(Artificial Substrates)

	April				May				June				July				August				September				October				November			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Amphipoda (scuds)																																
Crangonyx		-	-	-		-	-	-	x	-	-		-		-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-
Gammarus		-	-	x		-	-	-	-	-	-		-		-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-
Bryozoa		-	x	x		-	x	x	x	-	x		x		-	x	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-
Cladocera																																
Sida crystallina		-	-	-		-	-	-	-	-	-		-		-	-	-	-	-	-		-	-	-	-	-	-	-	x	x	x	x
Decapoda																																
Cambarus		-	-	-		-	-	-	-	-	-		x		-	-	-	-	-	-		-	-	-	-	x	-	x	-	-	-	-
Orconectes		-	-	-		-	-	-	-	x	-		-		-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-
Diptera																																
Chironomidae (midges)																																
Chironomus		-	-	-		-	-	-	-	-	-		x		x	x	x	x	x	x		x	-	x	x	x	x	x	x	x	x	x
C. Tentans		-	-	-		-	-	-	-	-	-		-		-	-	x	-	x	-		-	-	-	-	-	-	-	x	x	-	x
Dicrotendipes		-	-	x		x	x	x	x	x	x		x		x	x	x	x	x	x		-	-	-	-	-	-	-	x	-	-	x
Pentaneura		-	-	-		-	-	-	x	-	-		x		-	-	x	-	x	-		-	x	x	-	-	-	-	-	x	x	-
Procladius		-	-	-		-	-	-	-	-	-		-		-	-	-	-	-	-		-	-	-	-	-	-	-	x	x	-	-
Xenochironomus		-	-	-		-	-	-	-	-	-		x		-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-
Ephemeroptera (mayflies)																																
Caenis		-	-	-		-	-	-	-	-	-		-		-	-	-	-	-	-		-	-	-	-	x	-	-	-	-	-	-
Hexagenia bilineata		-	-	-		-	-	-	-	-	-		-		-	-	-	-	-	-		-	-	-	-	-	-	-	x	x	-	x
Stenonema		-	-	x		x	x	x	x		x				x	x			x	x		x	x	x		x	x	x	x	-	x	x
Hirudinea (leeches)		-	-	-		-	x	-	-	-	-		-		-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-
Isopoda																																
Lirceus		-	-	-		x	-	-	x	-	-		-		-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-
Odonata																																
Argia		-	-	-		-	-	-	-	-	-		-		-	-	-	x	-	-		-	-	-	-	-	-	-	-	-	-	-
Macromia		-	-	-		-	-	-	-	-	x		-		-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-
Oligochaeta																																
Branchiura sowerbyi		-	-	-		-	-	-	-	-	-		-		-	-	-	-	-	-		-	-	-	-	-	-	-	x	-	x	x
Limnodrilus		x	-	-		-	x	-	-	-	-		x		-	-	-	-	-	-		-	-	-	x	-	-	-	-	-	-	x

Table XI.8
(Continued)

	April				May				June				July				August				September				October				November			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Pelecypoda																																
Corbicula manilensis		-	-	-		-	x	-	-	-	-		-		-	-	x	x	-	-		x	x	x	x	x	x	x	-	x	x	x
Sphaerium		-	-	-		-	-	-	-	-	-		-		-	-	-	-	x	-		-	-	-	x	-	-	-	-	-	-	-
Trichoptera (caddisflies)																																
Cheumatopsyche		-	-	-		-	-	-	-	-	-		-		-	x	-	-	-	-		x	-	-	-	-	-	-	-	-	-	-
Cyrnellus		-	-	-		-	x	-	x	-	x		x		x	-	-	x	-	-		x	x	x	x	-	x	x	x	-	x	x
Psychomiid (Genus A)																																
Turbellaria																																
Cura foremanii		-	-	-		-	-	-	-	-	-		-		-	-	-	-	-	-		-	x	-	x	x	x	x	x	-	x	-

Note: 1 - CRM 14.4
2 - CRM 15.4
3 - CRM 17.9
4 - CRM 19.0
x = Presence of Taxa
- = Absence of Taxa
Blank = Sample was not recovered or was found above waterline

Table XI.9

Temporal and Spatial Distributions of Benthic Macroinvertebrates

Collected in the Vicinity of the Proposed CRBRP, Clinch River - 1976

(Artificial Substrates)

	May				July				September				November			
Taxa	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Amphipoda (scuds)																
Gammarus	-	-	-	-	x	-	x		-	-	-	-	-	-	-	-
Athecata																
Hydra americana	-	x	x	x	-	-	-		-	-	-	-	x	x	x	x
Cladocera																
Sida crystallina	x	-	x	-	x	x	x		x	-	x	x	x	-	-	-
Clitellata																
Branchiura sowerbyi	-	-	-	-	-	-	-		-	x	-	-	-	-	-	-
Limnodrilus	-	x	-	-	-	-	-		-	-	-	-	-	-	-	-
Limnodrilus claparedianus	-	-	-	-	-	-	-		-	-	-	-	x	x	-	-
Decapoda																
Cambarus	-	-	-	-	x	x	x		-	-	-	-	-	-	-	-
Orconectes	-	-	-	-	-	-	-		-	-	x	-	-	-	-	-
Diptera																
Chironomidae (midges)																
Chironomus	x	-	-	x	x	x	x		x	x	x	x	x	-	x	x
Cryptochironomus	-	x	-	-	-	-	-		-	-	-	-	-	-	-	-
Dicrotendipes	-	-	x	-	-	x	-		-	-	-	-	x	-	-	-
Parachironomus	x	-	x	x	x	x	x		x	-	x	x	x	-	-	-
Pentaneura	-	-	-	-	x	-	-		x	-	-	-	x	-	-	-
Ephemeroptera (mayflies)																
Caenis simulans	-	-	-	-	-	x	-		-	-	-	-	-	-	-	-
Stenonema	-	-	x	-	x	x	x		x	-	x	x	x	-	x	x
Stenonema tripunctatum	x	-	-	x	-	-	-		-	-	-	-	-	-	-	-
Heterodonata																
Corbicula manilensis	x	x	x	x	-	x	x		-	x	-	-	x	x	-	-
Hirudinea (leeches)	-	-	-	-	-	-	x		-	-	-	-	-	-	-	-
Isopoda																
Lirceus	-	-	x	-	-	-	-		-	-	-	-	-	-	-	-
Trichoptera (caddisflies)																
Cyrnellus	x	-	x	x	-	-	-		x	x	x	x	x	-	x	x
Hydropsyche	-	-	-	-	-	-	-		-	-	-	x	-	-	x	x
Neureclipsis	-	-	-	-	-	-	-		-	-	-	-	x	x	-	x
Tricladida																
Cura foremanii	-	-	-	-	x	x	x		x	-	x	x	x	-	x	x

1 - CRM 14.4
2 - CRM 15.4
3 - CRM 17.9
4 - CRM 19.0
x = Presence of taxa
- = Absence of taxa
Blank = Artificial substrates were not recovered or were found above waterline.

Table XI.10

Temporal and Spatial Distributions of the Benthic Macroinvertebrates Collected in the Vicinity of the Proposed CRBRP, Clinch River - 1977

(Artificial Substrates)

Taxa	May				July				September				November			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Amphipoda (scuds)																
Crangonyx							x		x		x	-				-
Cladocera																
Sida crystallina							-		x		x	x				-
Clitellata																
Lumbriculidae							-		-		x	-				-
Tubificidae							-		-		x	-				-
Coleoptera																
Dubiraphia							-		x		-	x				-
Decapoda																
Cambarus							-		x		-	-				-
Diptera																
Chironomidae (midges)							-		-		-	-				x
Ablabesmyia							x		x		-	-				-
Chironomus							x		-		x	-				-
Cricotopus							-		x		x	-				x
Cryptochironomus							-		x		-	-				-
Dicrotendipes							-		-		x	x				x
Endochironomus							-		x		-	-				-
Eukiefferiella							-		-		-	-				x
Glyptotedipes							-		x		-	x				x
Parachironomus							x		-		-	x				-
Polypedilum							-		-		-	x				-
Psectrocladius							-		-		x	x				x
Rheotanytarsus							-		x		-	x				x
Xenochironomus							-		-		-	-				-
Simulidae							-		-		-	-				-
Ephemeroptera (mayflies)																
Stenacron							x		x		x	x				-
Tricorythodes							x		-		-	-				-
Heterodonata																
Corbicula manilensis							-		x		x	x				-
Sphaerium							-		-		x	-				-
Isopoda																
Lirceus							x		-		-	-				-
Megaloptera																
Sialis							-		x		-	-				-
Mesogastropoda																
Pleurocera canaliculatum							-		-		x	-				-
Odonata																
Argia							-		x		-	-				-

Table XI.10
(Continued)

Taxa	May 1	May 2	May 3	May 4	July 1	July 2	July 3	July 4	September 1	September 2	September 3	September 4	November 1	November 2	November 3	November 4
Trichoptera (caddisflies)																
Agraylea							-		x		x	x				x
Cyrnellus							-		x		x	x				x
Hydroptila							x		-		-	-				-
Neureclipsis							-		-		-	-				x
Polycentropus							x		-		-	-				x
Tricladida																
Cura foremanii							x		-		-	-				-
Dugesia tigrina							-		-		-	-				x

1 - CRM 14.4
2 - CRM 15.4
3 - CRM 17.9
4 - CRM 19.0
x = Presence of Taxa
\- = Absence of Taxa
Blank = Artificial substrates were not recovered or were found above waterline.

Table XI.11

Prevalent Benthic Macroinvertebrate Taxa Collected in the Vicinity of the Proposed CRBRP, Clinch River - 1975, 1976, 1977

(Artificial Substrate Samples)

Taxa	Percent Occurrence
1975	
Stenonema	70.4
Chironomus	63.9
Corbicula manilensis	59.3
Dicrotendipes	59.3
Cyrnellus fraternus	55.6
1976	
Chironomus	80.0
Cyrnellus fraternus	66.7
Parachironomus	66.7
Stenonema	66.7
Corbicula manilensis	60.0
Cura foremanii	60.0
Sida crystallina	60.0
Hydra americana	46.7
1977	
Dicrotendipes	80.0
Stenacron	80.0
Agraylea	60.0
Corbicula manilensis	60.0
Cragonyx	60.0
Crictopus	60.0
Crynellus fraternus	60.0
Glyptotendipes	60.0
Psectrocladius	60.0
Rheotanytarsus	60.0
Sida crystallina	60.0

*Note - There were 27 collections in 1975, 15 in 1976, and 5 in 1977.

Table XI.12

Macroinvertebrate Standing Crop in the Vicinity

of the Proposed CRBRP, Clinch River - 1975, 1976, 1977

(Artificial Substrates) (Mean Number/Substrate)

		Clinch River Mile							
		14.4		15.4		17.9		19.0	
Year	Month	1	2	1	2	1	2	1	2
1975	April	*	*	1	-	1	-	2	-
	May	*	*	21	-	19	-	25	-
	June	28	-	44	-	74	-	*	*
	July	14	-	*	*	13	-	19	-
	August	8	-	10	-	42	-	18	-
	September	*	*	11	-	16	-	16	-
	October	19	-	18	-	11	-	33	-
	November	15	750	3	463	21	557	9	1289
1976	May	7	43	5	-	90	95	9	-
	July	29	658	16	75	18	746	*	*
	September	16	43	2	-	13	3	8	29
	November	61	65	5	-	1469	-	1355	-
1977	May	*	*	*	*	*	*	*	*
	July	*	*	*	*	16	-	*	*
	September	55	87	*	*	46	52	46	138
	November	*	*	*	*	*	*	25	-

* - Artificial substrates were not recovered or were found above the waterline.
\- - Sida crystallina was not collected in the samples.
1 - Sida crystallina not included in the data.
2 - Sida crystallina included in the data.

zone zooplankton species often found attached to the substrate. The standing crop ranged from 1 per substrate (CRM 15.4 and 17.9, April 1975) to 1469 (CRM 17.9, November 1976). The two highest standing crop estimates (1469 per substrate and 1355 per substrate) resulted from collecting large numbers of *Hydra americana*, a freshwater coelenterate. Standing crop estimates for individual taxa are given in Appendix Tables B.3.4, B.3.5, and B.3.6.

Table XI.13 lists the diversity index ($\bar{d}$) and equitability (e) values for organisms collected with artificial substrates without *Sida crystallina* data included. Table XI.14 lists diversity index and equitability values for only those stations at which *Sida crystallina* was collected. The diversity values ranged from 0.000 at CRM 15.4 and 17.9 in April 1975 to 2.989 in September 1976. When *Sida crystallina* was included in the calculation of $\bar{d}$, the value usually decreased. This occurred because of the substantial numbers of *Sida crystallina*. The addition of one species that is very abundant compared to the other taxa will decrease the value of $\bar{d}$ because of the unequal distribution of the number of organisms between taxa.

This is illustrated more dramatically with the $\bar{d}$ values at station CRM 17.9 in September 1976 and November 1976. The value of $\bar{d}$ was 2.321 and 2.573 with and without *Sida crystallina* included in September 1976. However, when evaluating the number of taxa and the distribution of organisms among those taxa, only eight taxa were present, but the organisms are quite evenly distributed among the taxa. The $\bar{d}$ values are relatively high compared to the others which can be somewhat misleading because in November 1976 six taxa were collected at station 17.9, but one taxa, *Hydra americana* was 85 times as abundant as the next dominant taxa. The $\bar{d}$ value was 0.149. This same condition occurred at CRM 19.0 during November 1976.

Table XI.13

Benthic Macroinvertebrate Community Indices ($\bar{d}$) and Equitability (e)

Values in the Vicinity of the Proposed CRBRP, Clinch River - 1975, 1976, 1977

(Artificial Substrate Samples - *Sida crystallina* excluded)

		Clinch River Mile							
		14.4		15.4		17.9		19.0	
Year	Month	$\bar{d}$	e	$\bar{d}$	e	$\bar{d}$	e	$\bar{d}$	e
1975	April	*	*	0.000	0.00	0.000	0.00	1.811	1.15
	May	*	*	0.213	0.40	0.420	0.50	1.065	0.36
	June	1.515	0.45	0.059	0.55	0.273	0.33	*	*
	July	1.477	0.44	*	*	0.744	0.38	0.049	0.22
	August	1.618	0.98	0.942	0.46	1.282	0.43	1.614	0.78
	September	*	*	1.375	0.64	2.108	1.20	1.770	0.88
	October	2.348	1.15	1.809	0.75	1.647	0.80	2.148	0.98
	November	2.299	0.74	2.228	1.10	1.863	0.67	2.284	0.72
1976	May	2.089	1.12	1.733	1.08	0.395	0.33	1.192	0.47
	July	2.301	0.96	2.396	0.89	0.233	0.13	*	*
	September	2.312	1.12	1.930	1.25	2.321	1.12	2.245	1.07
	November	2.513	0.71	1.818	1.15	0.149	0.18	0.189	0.17
1977	May	*	*	*	*	*	*	*	*
	July	*	*	*	*	2.955	1.09	*	*
	September	2.989	0.74	*	*	2.841	0.77	2.645	0.79
	November	*	*	*	*	*	*	2.613	0.60

* - Artificial substrates missing or found above the water line.

Table XI.14

Benthic Macroinvertebrate Community Indices ($\bar{d}$) and Equitability (e) Values in the Vicinity of the Proposed CRBRP, Clinch River - 1975, 1976, 1977

(Artificial Substrate Samples - *Sida crystallina* included)

		Clinch River Mile							
		14.4		15.4		17.9		19.0	
Year	Month	$\bar{d}$	e	$\bar{d}$	e	$\bar{d}$	e	$\bar{d}$	e
1975	November	1.314	0.32	0.652	0.26	1.144	0.33	1.261	0.30
1976	May	0.973	0.40	-	-	0.657	0.23	-	-
	July	0.349	0.16	1.270	0.32	0.223	0.13	-	-
	September	1.806	0.64	-	-	2.573	1.16	1.441	0.50
	November	2.694	0.74	-	-	-	-	-	-
1977	September	2.827	0.62	-	-	2.610	0.60	-	-

Note: This table includes only those stations that *Sida crystallina* was collected at.

- = *Sida crystallina* not present in the sample.

Biomass

Biomass estimates are presented in Tables XI.15 and XI.16. The estimates were reported in gm/m^2 (Ponar) and mg per substrate (Art. Sub. Sampler). The molluscan biomass ranged from 0.00 gm/m^2 at stations where no specimens were collected to 177.10 gm/m^2 (CRM 19.0, October 1975). Samples at the latter contained Corbicula manilensis and Quadrula. The predominant mollusc was Corbicula manilensis. The large biomass of 79.48 gm/m^2 at CRM 190 in May 1977 can be attributed to the presence of one Quadrula postulosa. Nonmolluscan biomass estimated ranged from 0.00gm/m^2 to 0.19 gm/m^2 at CRM 19.0 in June 1975.

The biomass estimates from the artificial substrates were less than those obtained by the Ponar grab sampler. Values ranged from 0.00 mg/substrate to 1345.42 (CRM 17.9, July 1976) for molluscan biomass. Biomass estimates ranged from 1.90 mg/substrate (CRM 15.4, September 1976) to 2839.12 mg/substrate (CRM 17.9, July 1976).

Discussion

The taxa found during this study were substantially different from those found by Westinghouse in the 1975 CRBRP ER. However, this would be expected because of the different station localities and habitats.

Weber (1973) compiled a taxonomic listing of some benthic macroinvertebrates that had been described as being tolerant, faculative, or intolerant to organic wastes. The following organisms or groups of organisms that were collected would be classed accordingly.

Table XI.15

Biomass of Benthic Macroinvertebrates Collected in the Vicinity of the Proposed CRBRP, Clinch River - 1975, 1976, 1977

(gm/m^2 - Wet Weights) (Ponar Grab Samples)

		Clinch River Mile							
		14.4		15.4		17.9		19.0	
Year	Month	M	NM	M	NM	M	NM	M	NM
1975	March	14.34	0.06	14.33	<0.01	3.33	0.06	8.79	<0.01
	April	<0.01	0.04	0.11	0.00	0.62	0.00	23.23	0.00
	May	6.87	0.15	1.42	0.00	2.10	0.55	0.00	0.11
	June	26.25	0.03	*	*	4.50	<0.01	<0.01	0.19
	July	0.00	0.01	0.14	0.00	0.44	0.00	0.83	0.00
	August	26.99	0.02	21.46	0.00	1.41	0.00	48.14	0.00
	September	7.99	0.05	61.81	0.04	23.91	0.02	16.53	0.11
	October	2.41	0.01	5.39	0.00	0.36	0.00	177.10	0.00
1976	March	0.03	0.00	*	*	0.05	0.00	*	*
	May	1.05	<0.01	0.03	0.00	*	*	0.06	0.09
	July	10.94	0.07	3.91	0.08	16.45	0.05	3.15	0.04
	September	0.38	0.04	0.18	0.00	0.10	0.01	1.23	0.03
1977	March	0.00	<0.01	21.71	0.00	45.89	<0.01	0.00	0.05
	May	29.17	0.00	24.32	0.00	*	*	79.48	0.00
	July	9.46	<0.01	*	*	0.00	0.02	0.00	<0.01
	September	40.46	0.04	+	+	0.00	0.02	0.00	<0.01

M - Mollusca
NM - Non-molluscan macroinvertebrates
* - No organisms present in the ponar grab samples
+ - Samples were missing

Table XI.16

Biomass of Benthic Macroinvertebrates Collected in the Vicinity of the Proposed CRBRP, Clinch River - 1975, 1976, 1977

(mg per artificial substrate sample - wet weights)

		Clinch River Mile							
		14.4		15.4		17.9		19.0	
Year	Month	M	NM	M	NM	M	NM	M	NM
1975	April	*	*	0.00	3.03	0.00	0.59	0.00	11.00
	May	*	*	0.00	43.47	0.00	984.73	2.46	85.67
	June	46.11	33.21	0.00	945.19	0.00	145.69	*	*
	July	0.00	32.64	*	*	0.00	22.50	0.00	37.05
	August	10.6	36.09	8.30	32.65	8.98	113.53	0.00	56.47
	September	*	*	327.26	14.48	237.12	41.26	291.06	64.85
	October	29.74	81.63	81.25	44.16	36.51	8.24	19.02	505.77
	November	0.00	190.24	169.77	100.85	126.17	163.82	547.71	197.21
1976	May	27.49	93.88	8.87	4.21	11.31	87.19	11.02	19.58
	July	0.00	1342.54	58.00	509.57	1345.42	2839.12	*	*
	September	0.00	55.96	24.74	1.90	0.00	1064.14	0.00	18.17
	November	4.98	94.78	7.43	8.07	0.00	377.06	0.00	900.05
1977	May	*	*	*	*	*	*	*	*
	July	*	*	*	*	0.00	61.43	*	*
	September	77.73	282.78	*	*	893.96	117.21	2.05	113.46
	November	*	*	*	*	*	*	0.00	48.59

M - Mollusca
NM - Non-Molluscan macroinvertebrates
* - Artificial substrates were not recovered or were found above the water line

Organism	Classification
Obligochaeta	tolerant
Gammorus	facultative
Decapoda	facultative
Chironomidae	intolerant to tolerant
Ephemeroptera	intolerant to tolerant
Odonata	facultative

Chironomids and mayflies are considered intolerant to tolerant depending on the species. The genus Argia was classified as intolerant by the listing; however, Tennessen (personal communication) considers it facultative.

Cyrnellus fraternus a net spinning caddisfly that builds its retreat in a depression of a rock by spinning a flattened silk roof (Wiggins, 1977) is indicative of rocky substate. Several other caddisflies collected also are indicative of rocky substrate. In addition, the presence of Cura foremanii and Dugesia tigrina also indicate the presence of a rocky substrate. In general, it can be said that the presence of the net-spinning caddisflies also indicate an area where heavy sedimentation does not occur. This would provide several indicators for the effects of sedimentation during construction.

It is difficult to compare the significance of percent composition and diversity when they are based upon different numbers of possible occurrences. Samples were collected monthly in 1975 and seasonally in 1976 and 1977. It is also difficult to compare the 1975 data collected with a Ponar sampler with that of 1976 and 1977 because of the different substrate sampled in 1975.

The selectivity for organisms of the two different sampling schemes is the reason for the difficulty in making any comparisons. This is especially true in 1977 when only 5 artificial substrate collections were made out of a possible 16. Yet, 32 taxa were collected in 1977 as compared to 29 taxa in 1975 and 17 taxa in 1976. The increase in taxa numbers in 1977 was primarily due to the collection of chironomids.

In general the diversity indices were indicative of benthic macroinvertebrate populations that were not very diverse. Evaluation of the data reveals that the number of taxa at any one station was not substantial. This was true of Ponar samples as well as artificial substrate samples. Equitability (e) values from zero to greater than 1.0 occurred frequently, in samples collected with the Ponar. An "e" value greater than one occurs when the distribution in the sample is more equitable than the distribution resulting from the MacArthur model. This occurs in samples containing only a few specimens with several taxa represented (Weber 1973). Weber also states that samples containing less than 100 organisms should be evaluated with caution when using the diversity index ($\bar{d}$) and (e) equitability values. Equitability values obtained from artificial substrate samples exceeded 1.0 a few times also. Therefore, some caution again must be used in evaluating diversity index values for artificial substrate samplers. The low diversity of benthic macroinvertebrates was also reported by Westinghouse in the 1975 CRBRP ER.

The biomass estimates for molluscan biomass are somewhat less than those reported by Westinghouse in the ER. The nonmolluscan data is quite similar. However, the estimates were obtained at different river miles and by different sampling methodology.

The biomass estimates from the artifical substrates were less than those obtained by the Ponar grab sampler. In general, the nonmolluscan biomass was greater than the molluscan when artificial substrates were used. This indicates a selectivity for nonmolluscan macroinvertebrates by the artificial substrate samplers. One would expect this because only small specimens of molluscs could penetrate the basket interspaces to colonize the substrate.

The substrate size range throughout the area was mostly granule to cobble with hardpan substrate prevalent throughout the area. This type of substrate is probably one of the limiting factors for the macroinvertebrate populations.

One difficulty in using artificial substrates is the low recovery percentage, caused by vandalism, displacement of samplers by high water velocities, and the difficulty in locating the samplers if markers are destroyed. It is also difficult to obtain good samples with the Ponar grab sampler in the substrate that is found in the area of the proposed CRBRP.

Conclusions

The data obtained using a Ponar grab sampler and artificial substrates indicated a macroinvertebrate population that is not very diverse and also low in numbers. In general, the fauna collected indicated a habitat that is substantially rocky in nature. The taxa collected differed extensively from those reported by Westinghouse in 1975. However, this was attributed to different station locations and habitat types.

Biomass and quantitative estimates indicate a selectivity of artificial substrates for nonmolluscan macroinvertebrates.

Several taxa could be used as indicators of excessive organic pollution and heavy sedimentation in the area.

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XII. Summary and Conclusions

XII. Summary and Conclusions

River Substrate Characteristics

Sediment samples were were collected at CRM 14.4, CRM 15.4, CRM 17.9, and CRM 19.0 on a monthly basis from March to October 1975 and a seasonal basis in 1976 (March, May, July, September) and 1977 (March, May, and July).

The substratum in the area of the CRBRP is predominantly coarse with the majority of the sediment being classified as rocky.

The sediments collected in 1975 indicated a similarity between CRM 14.4 and CRM 17.9. They also indicated a similarity between CRM 15.4 and CRM 19.0. However, in 1976 and 1977 the similarity between these stations was not as definable and is attributed to the collection of sediment samples at different locations.

The presence of considerable amounts of hardpan in the area may account for the low diversity of benthic fauna.

Clinch River Water Quality

Observed temperatures in the Clinch River were well below the State of Tennessee standard of 30.5°C. The river was well mixed with thermal gradients normally below 1°C. It appears that during periods of reverse flow warmer water from Poplar Creek flows upstream elevating river water temperatures. This was observed at CRM 14.4 with the warmest water measured at the right bank area.

Dissolved oxygen concentrations of the Clinch River were good, being greater than or equal to 5.0 mg/l. The water was well mixed in the vertical direction, with dissolved oxygen gradients normally less than 0.5 mg/l. Isolated low concentrations of dissolved oxygen, ranging from 3.2 to 4.7 mg/l, were measured at Melton Hill Dam tailrace. But there appears to be sufficient reaeration capacity in the river to increase levels to 5.0 mg/l within a short distance. Dissolved oxygen percent saturation levels did not indicate any areas of unusual oxygen production which would be attributed to widespread photosynthetic activity or areas of serious reduction in dissolved oxygen concentrations.

Measured concentrations of nutrients, most metals, and sanitary-chemical constituents were normally low. Elevated concentrations of mercury and COD were observed on isolated occasions. Concentrations of iron and manganese were above levels identified for finished drinking water. The water is considered to be moderately hard.

During rainfall events the river contained high total coliform densities. The high nonfecal ratio would indicate that the source of the bacteria is soil and vegetation.

Site Stormwater Runoff Water Quality

Rainfall intensity rather than the total amount of rainfall had a more significant impact on physical water quality in the drainageways. Surveys performed in conjunction with periods of intense rainfall resulted in the highest levels of suspended solids and turbidity measured in the drainageways. An evaluation of suspended solids and turbidity data showed that the observed values varied considerably and did not plot as a normal distribution. Logarithmic transformations of the data provided the following results:

	Suspended Solids (mg/l)	Turbidity (NTU)
Mean	28	37
One standard deviation	8.3, 96	8.7, 158
Two standard deviations	2.4, 324	2.0, 676

In 1975 five special rainfall surveys of the Clinch River were performed. Neither the total amount of rainfall or rainfall intensity could be clearly correlated to Clinch River physical water quality due to time delays between the rainfall events and surveys. In addition, a determination of whether the site was the source of the suspended solids and turbidity could not be made. Therefore, the data resulting from this activity is useful only for background determinations in the Clinch River after rainfall events. It is clearly shown by this evaluation that (1) rainfall intensity is significant to stormwater runoff quality, (2) the timing of stormwater runoff surveys is critical, and (3) stations located directly onsite upstream of any influence by the receiving waterbody, complemented with stations in the receiving waterbody, will provide the data necessary for an accurate assessment of the impact of site stormwater runoff on physical water quality in the receiving waterbody.

Ground Water Quality

An evaluation of all ground water data clearly showed a quality variation with differing sampling techniques. The sampling technique utilized for the nonpumped observation wells did not allow for the removal of the standing water in the casing. This resulted in a contaminated sample. The source of contamination would most likely be solids entering the casing from the host formation and corrosion of the metal casing. Additionally, acidification of a contaminated sample to a pH of 2.0 S.U. would dissolve suspended solids in the water and solubilize most metals contained in these solids. These solids normally would not be present in a sample obtained from a well properly flushed prior to sampling. Therefore, the data obtained from the unpumped wells did not properly represent the quality of water in the formation at the site and should not be construed as such.

An evaluation of the data obtained from the pumped well showed that at the site ground water quality was good. Concentrations of dissolved solids were low, averaging 230 mg/l. Concentrations of analyzed nutrients and metals were normally low and on many occasions below detectable limits.

Phytoplankton

The most common phytoplankton genera found throughout the sampling reach were *Melosira*, *Synedra*, *Stephanodiscus*, *Chlamydomonus*, *Scenedesmus*, *Dactylococcopis*, *Anacystis*, and *Trachelomonas*. Generally the Chrysophytes were dominant mostly during the spring, the Chlorophyta during the summer, and the Cyanophytes during the fall.

Numbers of phytoplankton generally start increasing during May with the largest peaks occurring in October. Highest concentrations were over 3,700,000 cells/ℓ at CRM 14.4 during October. Concentrations of less than 100,000 cells/ℓ only occurred during March at CRM's 17.9 and 19.0.

Chlorophyll a and productivity rates generally followed the same pattern, especially with relatively lower values during the months of March, April, and May of each year during the monitoring period. May was an exceptional month during 1977 for productivity rates with higher than usual values. The comparisons of 1976 and 1977 productivity rates show similarity with normal annual variations caused by seasonal temperature and turbidity differences in the water.

All three phytoplankton parameters (standing crop, chlorophyll a, and productivity) indicated a patchy distribution primarily controlled by a continuous moving flow pattern of the Clinch River with increases observed downstream from CRM 19.0 as the water mass velocity decreased and the retention time became longer. Productivity was also greater in the channel areas than in the overbank areas for surface area measurements due to deeper waters, but similar for per unit area measurements.

Periphyton

One hundred and twenty-four Plexiglass® artificial substrates (64.6 percent recovery), incubated for four weeks, were analysed for chlorophyll a concentrations in 1975. In addition, 22 (45.8 percent of the original) artificial substrates were analyzed for algal-division percent composition, total numbers, and generic composition.

The data indicated that Chrysophytes (diatoms) are the dominant algal group at each of the stations. It also indicated that the genus Achnanthes comprises the majority of the Chrysophyta community and as such a majority of the entire periphyton community at times. The autotrophic index data was highly variable both temporarily and spatially.

Zooplankton

Sixty-four samples were collected during 1975 to characterize the zooplankton population in the vicinity of the proposed CRBRP project. These samples revealed a diverse and abundant fauna throughout the study area with seasonality a major influencing factor on species occurrence and abundance. Rotifers were the predominant zooplankton at all stations with the exception of April when the Cladocera were the dominant group.

Seasonal effects on rotifers are quite dramatic with large abundances occurring in 1975 during the months of May and October for some species and May, August, and September for others. Five species were primarily responsible for rotifer abundance throughout the year.

One species of Cladocera, Bosmina longirostris, was found on all sampling dates and was the dominant Cladoceran at most stations throughout the year.

Diversity indices did indicate seasonal changes in number of taxa and abundance within those taxa.

There were no dramatic differences between the four stations with respect to the zooplankton population. The predominance of five rotifer species and one cladoceran species should provide a good basis on which to determine effects of construction and operation of a plant. Any major shifts in abundance of these species or replacement of them by others would provide a key to determine possible environmental changes. A shift from a predominant rotifer population to either a cladoceran or copepod population would also be an excellent criteria to assess any effects, natural or manmade.

Benthic Macroinvertebrates

Benthic macroinvertebrate fauna in the vicinity of the proposed Clinch River Breeder Reactor project was sampled on a monthly basis in 1975 and a seasonal basis in 1976 and 1977 using a Ponar grab sampler and artificial substrate samples.

The data obtained by both methods indicated a macroinvertebrate population that is not very diverse and also low in numbers. In general, the fauna collected indicate a habitat that is substantially "rocky" in nature. This term implies a range from gravel to pebble sized substrate.

The taxa collected differed extensively from those reported by Westinghouse in 1972. However, this was attributed to different station locations and habitat types.

Biomass and quantitative estimates indicate a selectivity of artificial substrates for non-molluscan macroinvertebrates.

Several taxa could be used as indicators of excessive organic solution and heavy sedimentation in the area.

Appendix A

Water Quality Data

TABLE A.1

SITE STORMWATER RUNOFF DATA
CLINCH RIVER BREEDER REACTOR PLANT SITE
(1975)

Date	Clinch River 14.4			At Unnamed Trib. 0.01 Clinch River 14.L			Grassy Creek 0.01			Clinch River 15.4														
										5%			25%			50%			75%			95%		
(1975)	pH	Turb. (JTU)	Sus. Sol. (mg/l)	pH	Turb. (JTU)	Sus. Sol. (mg/l)	pH	Turb. (JTU)	Sus. Sol. (mg/l)	pH	Turb. (JTU)	Sus. Sol. (mg/l)	pH	Turb. (JTU)	Sus. Sol. (mg/l)	pH	Turb. (JTU)	Sus. Sol. (mg/l)	pH	Turb. (JTU)	Sus. Sol. (mg/l)	pH	Turb. (JTU)	Sus. Sol. (mg/l)
03/11	7.9	6.4	10	-	-	-	-	-	-	-	-	-	-	-	-	7.9	7.5	5	-	-	-	-	-	-
*03/31	-	-	-	-	37.0	24	-	64.0	27	-	32.0	21	-	32.0	26	-	33.0	28	-	32.0	22	-	34.0	19
04/16	8.0	5.8	14	-	-	-	-	-	-	-	-	-	-	-	-	8.0	5.1	10	-	-	-	-	-	-
*05/16	8.0	1.6	3	8.1	10.0	12	8.15	25.0	5	-	-	-	-	-	-	8.0	1.8	3	-	-	-	-	-	-
05/22	8.2	1.9	2	-	-	-	-	-	-	-	-	-	-	-	-	8.2	2.4	6	-	-	-	-	-	-
*06/12	-	-	-	-	29.0	27	-	20.0	18	-	8.9	9	-	8.6	11	-	8.2	10	-	9.0	10	-	9.6	12
06/18	7.9	8.0	2	-	-	-	-	-	-	-	-	-	-	-	-	7.9	6.5	3	-	-	-	-	-	-
07/15	7.49	4.0	2	-	-	-	-	-	-	-	-	-	-	-	-	7.47	4.3	2	-	-	-	-	-	-
08/07	7.30	3.7	6	-	-	-	-	-	-	-	-	-	-	-	-	7.30	4.4	7	-	-	-	-	-	-
09/16	7.40	2.0	4	-	-	-	-	-	-	-	-	-	-	-	-	7.50	1.7	4	-	-	-	-	-	-
*09/24	7.80	10	8	7.90	14	14	7.90	13	16	7.80	19	20	7.80	20	24	7.80	21	25	7.80	25	27	7.80	-	9
*10/09	7.40	4.7	9	7.55	11	14	7.50	7.3	10	7.50	3.8	8	7.60	4.2	6	7.60	4.6	6	7.60	4.4	7	7.69	4.3	10
10/15	7.90	4.4	9	-	-	-	-	-	-	-	-	-	-	-	-	7.80	4.8	7	-	-	-	-	-	-

Date	Poplar Springs Valley Creek 0.01			Caney Creek 0.01			Clinch River 17.9															Clinch River 19.0		
							5%			25%			50%			75%			95%					
(1975)	pH	Turb. (JTU)	Sus. Sol. (mg/l)	pH	Turb. (JTU)	Sus. Sol. (mg/l)	pH	Turb. (JTU)	Sus. Sol. (mg/l)	pH	Turb. (JTU)	Sus. Sol. (mg/l)	pH	Turb. (JTU)	Sus. Sol. (mg/l)	pH	Turb. (JTU)	Sus. Sol. (mg/l)	pH	Turb. (JTU)	Sus. Sol. (mg/l)	pH	Turb. (JTU)	Sus. Sol. (mg/l)
03/11	-	-	-	-	-	-	-	-	-	-	-	-	7.95	5.5	3	-	-	-	-	-	-	8.0	1.2	5
*03/31	-	54.0	30	-	48.0	24	-	36.0	30	-	36.0	30	-	48.0	35	-	36.0	31	-	52.0	42	-	-	-
04/16	-	-	-	-	-	-	-	-	-	-	-	-	8.0	5.4	12	-	-	-	-	-	-	8.0	4.4	10
*05/16	8.0	21.0	25	8.1	32.0	32	-	-	-	-	-	-	8.1	1.6	3	-	-	-	-	-	-	7.9	2.0	4
05/22	-	-	-	-	-	-	-	-	-	-	-	-	8.15	2.0	4	-	-	-	-	-	-	8.1	1.5	2
*06/12	-	34.0	28	-	23.0	19	-	8.3	9	-	7.8	8	-	7.5	8	-	10.0	4	-	10.0	14	-	-	-
06/18	-	-	-	-	-	-	-	-	-	-	-	-	7.80	6.8	3	-	-	-	-	-	-	7.75	6.1	3
07/15	-	-	-	-	-	-	-	-	-	-	-	-	7.46	4.2	2	-	-	-	-	-	-	7.49	4.2	1
08/07	-	-	-	-	-	-	-	-	-	-	-	-	7.30	4.6	7	-	-	-	-	-	-	7.35	4.4	7
09/16	-	-	-	-	-	-	-	-	-	-	-	-	7.50	2.2	4	-	-	-	-	-	-	7.45	2.5	5
*09/24	7.90	28	30	7.90	20	18	7.90	17	19	7.80	17	18	7.85	20	21	7.80	22	22	7.80	21	23	7.80	14	12
*10/09	7.60	24	28	7.70	31	36	7.70	3.9	5	7.60	4.4	6	7.60	4.6	12	7.70	4.2	6	7.70	3.9	10	7.60	4.3	8
10/15	-	-	-	-	-	-	-	-	-	-	-	-	7.90	3.6	3	-	-	-	-	-	-	7.80	3.8	6

*Special surveys conducted during heavy rainfall event. All other data obtained during routine water quality surveys.

TABLE A.2

SITE STORMWATER RUNOFF DATA
CLINCH RIVER BREEDER REACTOR PLANT SITE[1]
(1976-1978)

Date ( )	Clinch River 15.5R (0.4km)[2]					Clinch River 15.95R (0.1km)[2]					Clinch River 16.1 (0.2km)[2]					Clinch River 16.5 (2.4km)[2]				
	Time	Temp (°C)	pH (S.U.)	Sus. Sol. (mg/l)	Turb. (NTU)	Time	Temp (°C)	pH (S.U.)	Sus. Sol. (mg/l)	Turb. (NTU)	Time	Temp (°C)	pH (S.U.)	Sus. Sol. (mg/l)	Turb. (NTU)	Time	Temp (°C)	pH (S.U.)	Sus. Sol. (mg/l)	Turb. (NTU)
06/03/76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	4.1
07/12/76	-	-	-	-	-	-	-	-	-	-	-	-	-	15	6.5	-	-	-	41	34
12/02/76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.6
11/21/77	1332	11.0	8.0	52	95	1338	11.0	7.9	46	90	1350	10.6	7.6	150	190	1345	11.0	7.9	28	60
12/19/77	-	-	-	-	-	-	-	-	-	-	1306	7.2	7.9	6.0	12	1315	9.2	7.8	3.0	6.0
01/23/78	-	-	-	-	-	1320	2.0	8.4	11	38	1326	1.2	8.8	8.0	10	1336	7.0	8.7	7.0	5.4
02/21/78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1310	3.0	7.8	4.0	2.3
03/30/78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1102	9.5	7.5	11	8.1
04/18/78	1125	16.5	7.6	39	120	1115	15.8	7.2	110	220	1100	14.9	6.9	600	700	1040	14.0	6.1	62	110
05/04/78	-	-	-	-	-	1250	14.0	6.2	22	38	1300	13.5	5.7	32	80	1315	12.3	6.5	27	50
06/08/78	1215	18.5	7.6	67	96	1210	19.0	7.4	150	250	1155	19.0	6.3	120	210	1130	18.0	6.0	12	27
07/26/78	-	-	-	-	-	1110	21.5	6.7	24	45	1100	20.8	6.4	45	55	1045	19.0	6.6	40	23
09/11/78	-	-	-	-	-	1000	21.0	7.6	80	80	1020	21.2	7.7	30	34	1030	21.8	7.3	12	5.0

[1]Dash indicates that no flow conditions existed during the survey.
[2]Distance from mouth of drainageway.

TABLE A.3

GROUND WATER QUALITY DATA

CLINCH RIVER BREEDER REACTOR PLANT SITE*

Identification	Date	Temp (°C)	pH (S.U.)	Cond. (μmhos)	Alkalinity (as $CaCO_3$)	P (Dissolved)	P (Total)	TDS	SS	Na	SO_4	B	Cd	Cr	Cu	Pb	Mn	Ni	Zn
Observation Well (Auto-Sampled)	6-4-76	16.2	6.8	350	170	0.01	0.03	200	-	1.6	1.0	0.10	0.001	<0.005	<0.01	<0.01	0.04	<0.05	0.21
	7-13-76	15.0	7.2	380	180	-	0.03	210	-	8.6	10	0.09	<0.001	0.017	0.01	<0.01	0.02	<0.05	0.33
	8-5-76	16.0	7.35	450	220	0.03	0.05	270	1	31	2.0	-	<0.001	<0.005	0.02	<0.01	<0.01	<0.05	0.45
	12-3-76	14.0	7.15	410	240	0.01	0.02	240	<1	49	12	0.25	<0.001	<0.005	0.02	<0.01	<0.01	0.07	0.13
	4-28-77	14.0	6.2	390	210	0.02	0.02	260	2	18	12	0.22	<0.001	<0.005	0.02	<0.01	<0.01	<0.05	0.34
	7-29-77	18.0	6.9	300	290	0.02	0.05	200	2	2.0	11	-	0.003	<0.005	0.03	<0.01	<0.01	<0.05	0.29
	10-13-77	13.1	7.16	400	202	0.02	0.04	240	2	8.2	14	0.14	<0.001	<0.005	0.01	<0.01	0.02	<0.05	0.32
	Maximum	18.0	7.35	450	290	0.03	0.05	270	2	49	14	0.25	0.003	0.017	0.03	<0.01	0.04	0.07	0.45
	Minimum	13.1	6.2	300	170	0.01	0.02	200	<1	1.6	1.0	0.09	<0.001	<0.005	<0.01	<0.01	<0.01	<0.05	0.13
	Mean	15.2	7.0	380	216	0.02	0.03	230	2	17	9.0	0.16	<0.001	<0.007	0.02	<0.01	<0.02	<0.05	0.30
	Median	15.0	7.15	390	210	0.02	0.03	240	2	8.6	11	0.14	<0.001	<0.005	0.02	<0.01	<0.01	<0.05	0.32
	Std. Deviation	1.7	0.39	48	40	0.01	0.01	28	0.5	17.5	5.2	0.07	0.001	0.004	0.01	-	0.01	0.01	0.10
WEll A-58	6-4-76	16.0	6.9	400	200	0.01	0.06	220	-	1.2	<1	0.09	0.0	<0.005	<0.01	<0.10	-	<0.05	0.38
	7-13-76	27.0	7.7	380	190	-	0.05	220	-	1.2	6	0.07	<0.001	0.022	0.08	0.0	0.04	<0.05	0.20
	8-5-76	16.0	6.9	410	230	-	0.02	240	9.0	1.4	2	-	<0.001	<0.005	0.04	0.0	-	<0.05	0.12
	12-3-76	13.0	7.0	450	300	0.01	0.02	260	2.0	38	6	0.28	<0.001	<0.005	<0.01	0.018	0.03	<0.05	0.04
	4-28-77	15.0	6.2	370	200	0.04	-	230	8.0	1.3	5	0.12	<0.001	<0.005	0.03	0.0	0.01	<0.05	0.05
	7-29-77	17.0	6.9	400	250	0.01	0.02	310	10	3.8	8	-	<0.001	<0.005	0.03	<0.010	<0.01	<0.05	0.03
	10-13-77	14.0	7.46	470	273	0.01	0.05	270	26	32	3	0.26	<0.001	<0.005	0.01	0.018	0.03	<0.05	0.02
	Maximum	27.0	7.7	470	300	0.04	-	310	26	38	8	0.28	0.061	0.022	0.08	0.0	0.14	<0.05	0.38
	Minimum	13.0	6.2	370	190	0.01	0.02	220	2.0	1.2	<1	0.07	<0.001	<0.005	<0.01	<0.010	<0.01	<0.05	0.02
	Mean	17.0	7.0	410	240	0.02	0.14	250	11	11	4	0.16	<0.010	<0.007	0.03	0.050	0.05	<0.05	0.12
	Median	16.0	6.9	410	230	0.01	0.05	240	9.0	1.4	5	0.12	<0.001	<0.005	0.03	0.018	0.03	<0.05	0.05
	Std. Deviation	4.7	0.48	36.3	42	0.01	0.28	33	8.9	16.3	2	0.10	0.023	0.006	0.02	0.061	0.04	-	0.13

TABLE A.3
(Continued)

Identification	Date	Temp (°C)	pH (S.U.)	Cond. (µmhos)	Alkalinity (as $CaCO_3$)	P (Dissolved)	P (Total)	TDS	SS	Na	SO_4	B	Cd	Cr	Cu	Pb	Mn	Ni	Zn
E-60	6-4-76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7-13-76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	8-5-76	16.0	7.3	400	220	0.01	0.01	230	25 -	15	2	-	<0.001	<0.005	0.04	-	-	<0.05	0.11
	12-3-76	12.0	6.9	410	240	0.01	0.02	240	11	15	2	0.12	-	<0.005	-	-	-	-	-
	4-28-77	15.0	6.4	400	220	0.01	0.01	240	19	13	2	0.11	<0.001	0.010	0.08	-	-	<0.05	0.08
	7-29-77	17.0	6.8	400	220	<0.01	<0.01	240	12	-	<1	-	<0.001	<0.005	0.10	-	-	<0.05	0.23
	10-13-77	13.0	7.2	430	236	<0.01	0.01	240	24	15	3	0.10	<0.001	<0.005	0.01	0.022	-	<0.05	0.01
	Maximum	17.0	7.3	430	240	0.01	0.02	240	24	-	3	0.12	<0.001	0.010	0.10	-	0.17	<0.05	0.23
	Minimum	12.0	6.4	400	220	<0.01	<0.01	230	11	13	<1	0.10	<0.001	<0.005	0.01	0.022	0.16	<0.05	0.01
	Mean	15.0	6.9	410	230	0.01	0.01	240	18	38	2	0.11	<0.001	<0.006	0.06	0.243	0.16	<0.05	0.11
	Median	15.0	6.9	400	220	0.01	0.01	240	19	15	2	0.011	<0.001	<0.005	0.06	0.210	0.17	<0.05	0.11
	Std. Deviation	2.1	0.4	13	10	-	0.004	4	6	52	1	0.010	-	0.002	0.04	0.211	0.01	-	0.09
R-62	6-4-76	17.0	6.9	480	250	<0.01	0.04	280	-	1.7	21	0.100	0.100	<0.005	<0.01	0.026	-	<0.05	0.22
	7-13-76	18.0	6.9	560	280	0.02	0.02	320	-	1.7	24	0.150	<0.001	0.014	0.09	<0.010	0.01	<0.05	0.15
	8-5-76	20.0	7.5	480	-	-	0.01	330	11	8.0	4.0	-	<0.001	<0.005	0.02	0.018	-	<0.05	0.05
	12-3-76	12.0	6.7	490	280	<0.01	0.01	290	21	2.1	6.0	0.120	<0.001	0.010	0.03	0.019	0.02	<0.05	0.04
	4-28-77	14.0	6.4	450	250	0.01	0.02	310	8.0	1.7	20	0.150	<0.001	<0.005	0.02	0.013	0.03	<0.05	0.06
	7-29-77	15.0	6.6	480	240	0.02	0.05	350	43	-	-	-	-	-	-	-	-	-	-
	10-13-77	15.5	7.38	320	280	<0.01	0.05	320	25	1.4	13	0.130	<0.001	<0.005	0.01	<0.010	0.05	<0.05	0.04
	Maximum	20.0	7.5	560	280	0.02	0.05	350	43	8.0	24	0.150	0.100	0.014	0.09	0.026	0.13	<0.05	0.22
	Minimum	12.0	6.4	320	240	<0.01	0.01	280	8.0	1.4	4.0	0.100	<0.001	<0.005	0.01	<0.010	0.01	<0.05	0.04
	Mean	16.0	6.9	470	260	<0.01	0.03	-	22	2.8	15	0.130	<0.018	<0.007	0.03	0.016	0.05	<0.05	0.09
	Median	15.5	6.9	480	280	0.01	0.02	320	21	1.7	17	0.130	<0.001	0.005	0.02	0.018	0.04	<0.05	0.05
	Std. Deviation	2.7	0.4	72	19	0.005	0.02	24	14	2.6	8.3	0.021	0.040	0.004	0.03	0.006	0.04	-	0.08

TABLE A.3
(Continued)

Identification	Date	Temp (°C)	pH (S.U.)	Cond. (μmhos)	Alkalinity (as $CaCO_3$)	P (Dissolved)	P (Total)	TDS	SS	Na	SO_4	B	Cd	Cr	Cu	Pb	Mn	Ni	Zn
G-68	6-4-76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7-13-76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	8-5-76	15.0	7.8	370	180	0.04	0.05	200	38 -	6.6	2.0	-	0.033	<0.005	0.10	-	-	<0.05	0.39
	12-3-76	13.0	6.8	360	210	0.01	0.02	180	36	6.3	15	0.110	0.038	<0.005	0.10	-	-	<0.05	-
	4-28-77	15.0	6.4	370	180	0.02	0.02	220	19	6.3	10	0.120	0.010	<0.005	0.06	0.048	-	<0.05	0.13
	7-29-77	19.0	6.5	380	190	0.01	0.02	240	32	6.6	11	-	0.006	<0.005	0.08	-	-	<0.05	0.18
	10-13-77	13.3	7.2	280	212	<0.01	0.03	230	8.0	6.9	8.0	0.120	0.006	<0.005	0.05	-	-	<0.05	0.11
	Maximum	19.0	7.8	380	212	0.04	0.05	240	-	6.9	15	0.120	0.038	<0.005	0.10	0.200	0.40	<0.05	1.30
	Minimum	13.0	6.4	280	180	<0.01	0.02	180	8.0	6.3	2.0	0.110	0.006	<0.005	0.05	0.048	0.23	<0.05	0.11
	Mean	15.0	6.9	350	194	0.02	0.03	210	27	6.5	9.0	0.120	0.019	<0.005	0.08	0.109	0.28	<0.05	0.42
	Median	15.0	6.8	370	190	0.01	0.02	220	32	6.6	10	0.120	0.010	<0.005	0.08	0.110	0.24	<0.05	0.18
	Std. Deviation	2.4	0.6	41	15	0.01	0.01	24	13	0.2	4.8	0.006	0.016	-	0.02	0.059	0.07	-	0.50
A-70	6-4-76	17.0	7.0	390	210	<0.01	-	200	-	1.8	2.0	0.150	-	<0.005	0.56	-	-	0.10	-
	7-13-76	18.0	7.3	420	220	<0.01	0.01	210	-	0.6	1.0	0.080	0.004	0.029	0.03	0.016	0.03	<0.05	0.09
	8-5-76	15.0	7.2	440	260	0.01	0.04	230	-	0.6	2.0	0.120	0.001	0.012	0.06	-	0.08	<0.05	0.15
	12-3-76	13.0	6.9	470	310	0.01	0.02	240	-	1.2	2.0	0.100	0.002	0.011	0.03	<0.010	0.04	0.07	0.05
	4-28-77	14.0	6.2	370	210	0.02	0.02	210	-	0.8	4.0	<0.10	0.012	<0.005	0.04	-	-	<0.05	0.05
	7-29-77	16.0	6.5	390	260	0.01	0.06	270	-	1.6	3.0	-	0.003	<0.005	0.03	<0.010	-	<0.05	0.04
	10-13-77	12.5	7.15	420	250	<0.01	0.02	230	-	0.4	3.0	0.120	0.003	<0.005	0.02	0.015	-	<0.05	0.02
	Maximum	18.0	7.3	470	310	0.02	0.10	270	270	1.8	4.0	0.150	0.150	0.029	0.56	0.240	0.60	0.10	1.8
	Minimum	12.5	6.2	370	210	<0.01	0.02	200	37	0.4	1.0	0.080	0.001	<0.005	0.02	<0.010	0.03	<0.05	0.02
	Mean	15.1	6.9	410	250	0.01	0.04	230	152	1.0	2.0	0.110	0.025	<0.010	0.11	0.063	0.18	<0.06	0.31
	Median	15.0	7.0	420	250	0.01	0.02	230	150	0.8	2.0	0.100	0.003	<0.005	0.03	0.016	0.08	<0.05	0.05
	Std. Deviation	2.0	0.4	34	36	0.004	0.03	24	99	0.5	1.0	0.024	0.0552	0.009	0.20	0.085	0.21	0.029	0.657

TABLE A.3
(Continued)

Identification	Date	Temp (°C)	pH (S.U.)	Cond. (μmhos)	Alkalinity (as $CaCO_3$)	P (Dissolved)	P (Total)	TDS	SS	Na	SO_4	B	Cd	Cr	Cu	Pb	Mn	Ni	Zn
N-70	6-4-76	21.0	7.4	380	200	<0.01	0.03	170	-	10.0	2.0	0.240	-	<0.005	0.03	<0.010	-	<0.05	-
	7-13-76	28.0	7.6	510	260	0.07	0.10	280	-	10.0	13	0.240	0.004	0.009	0.07	0.041	-	<0.05	0.33
	8-5-76	21.0	7.6	250	130	<0.01	0.01	100	16	11.0	2.0	-	0.002	<0.005	0.08	-	-	<0.05	0.11
	12-3-76	13.0	6.7	590	380	<0.01	0.01	320	-	5.8	1.0	0.140	<0.001	<0.005	0.03	<0.010	-	<0.05	0.02
	4-28-77	15.0	6.3	590	480	0.02	0.02	380	-	9.7	2.0	0.23	0.001	<0.005	0.03	0.025	-	<0.05	0.05
	7-29-77	20.0	6.9	480	210	0.01	0.02	330	56	6.1	<1.0	-	0.002	<0.005	0.03	<0.010	-	<0.05	0.04
	10-13-77	15.1	7.2	500	355	<0.01	0.09	340	210	5.4	3.0	0.180	0.004	<0.005	0.02	0.025	-	<0.05	0.08
	Maximum	28.0	7.6	590	480	0.07	0.10	380	210	11.0	13	0.240	0.140	0.009	0.08	0.350	4.0	<0.05	3.3
	Minimum	13.0	6.3	250	130	<0.01	0.01	100	16	5.4	<1.0	0.140	<0.001	<0.005	0.02	<0.010	0.22	<0.05	0.02
	Mean	19.0	7.1	470	290	<0.02	0.04	270	98	8.3	3.0	0.210	0.022	<0.006	0.04	0.067	1.46	<0.05	0.56
	Median	20.0	7.2	500	260	<0.01	0.02	320	100	9.7	2.0	0.180	0.002	<0.005	0.03	0.025	0.66	<0.05	0.08
	Std. Deviation	5.1	0.5	121	122	0.02	0.04	102	73	2.4	4.3	0.044	0.052	0.002	0.02	0.125	1.48	-	1.21

*Units are mg/l, unless otherwise noted.

Appendix B

Aquatic Biological (Nonfish) Data

Table B.1.1

SPATIAL AND SEASONAL DISTRIBUTION OF PHYTOPLANKTON TAXA WITHIN THE VICINITY OF THE CRBRP

CLINCH RIVER, MARCH 1975 - OCTOBER 1975

	March 11				April 16				May 22				June 18				July 15				August 7				September 16				October 15			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
CHRYSOPHYTA																																
Achnanthes					X								X	X	X			X	X	X					X	X	X	X	X	X	X	X
Asterionella					X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X					
Attheya	X																				X											
Chaetoceros					X	X									X			X														
Cocconeis	X				X	X						X		X				X	X						X	X	X	X	X	X		
Cymbella					X					X	X	X		X	X	X		X	X	X			X	X		X		X		X		
Diatoma					X			X					X			X																
Dinobryon	X	X	X						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Eunotia																							X									
Fragilaria														X				X	X	X					X	X						
Gomphonema		X	X	X	X	X							X	X		X	X									X	X					
Gyrosigma		X	X	X							X	X			X														X	X	X	X
Melosira	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X
Navicula		X	X	X	X		X		X	X	X		X	X	X	X			X		X	X		X	X	X	X		X	X	X	X
Neidium																	X															
Nitzschia													X															X	X		X	
Stauroneis																												X				
Stephanodiscus	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X
Surirella																									X							
Synedra	X	X			X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Synura																	X								X	X	X	X				
Tabellaria		X							X																							
CHLOROPHYTA																																
Acanthosphaera																					X			X	X				X			
Actinastrum									X		X		X	X	X			X	X			X		X	X	X	X	X	X	X	X	
Ankistrodesmus	X								X		X		X	X	X	X	X	X	X	X			X		X	X	X	X	X	X	X	X
Arthrodesmus									X			X												X	X							
Asterococcus																																
Botryococcus																				X					X	X	X	X		X	X	X
Carteria								X			X		X				X	X	X	X		X								X		
Chlamydomonas	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Chlorella						X					X	X	X	X	X	X		X	X	X		X		X	X	X	X	X	X	X	X	X
Chlorococcum													X																	X		
Chlorogonium		X					X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X
Chodatella		X					X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X
Closteridium															X	X																
Closteriopsis					X	X	X	X					X	X	X	X	X	X	X	X					X			X	X	X		X
Closterium											X			X												X	X	X	X	X	X	X
Coelastrum											X		X		X	X	X	X	X	X	X	X	X				X		X	X		
Colenkinia																																
Crucigenia													X		X	X	X			X			X	X	X	X	X	X	X	X		X
Dactylococcus																						X										

Table B.1.1 - Con't

	March 11				April 16				May 22				June 18				July 15				August 7				September 16				October 15			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Dictyosphaerium			X						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Elakatothrix											X	X					X			X	X	X		X			X	X		X	X	
Franceia														X	X	X	X	X	X	X					X	X	X	X	X	X	X	X
Gloeoactinium											X	X		X			X							X					X	X		
Golenkinia								X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Gonium																			X											X		
Kirchneriella										X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X
Micractinium										X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
Microspora																							X									
Mougeotia													X			X		X	X	X					X		X				X	X
Oocystis					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pandorina						X	X	X			X	X	X	X	X	X	X		X	X	X			X	X				X			X
Pediastrum													X	X		X			X			X		X	X	X	X	X				
Platydorina																			X						X	X	X	X	X	X	X	X
Pleodorina																X																
Planktospaeria															X														X			
Protococcus							X			X									X	X							X	X	X	X	X	X
Pteromonas								X		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X	X
Pyramimonas																	X	X	X	X								X				
Quadrigula										X					X	X	X								X			X	X			
Scenedesmus			X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Schroederia	X	X			X						X		X	X		X	X	X	X	X							X	X	X			X
Selenastrum													X	X		X			X													
Spaerocystis											X																					
Staurastrum			X											X																		
Stigeoclonium							X																									
Tetradesmus																X															X	
Tetraedron										X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Tetrastrum													X	X		X	X													X		X
Treubaria											X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X
Trochiscia														X		X									X	X	X					
Ulothrix					X	X	X	X					X	X	X	X							X				X					
Other																	X															X
CYANOPHYTA																																
Anabaena													X	X		X	X		X				X				X					
Anacystis	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Aphanizomenon	X	X																														
Aphanocapsa																													X			
Aphanothece																X																

Table B.1.1 - Con't

	March 11				April 16				May 22				June 18				July 15				August 7				September 16				October 15			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Chroococcus													X							X					X	X		X	X	X	X	X
Dactylococcopsis	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Gloeocapsa																																
Gomphosphaeria									X			X										X	X									
Lyngbya																													X			
Merismopedia	X	X									X	X	X	X	X	X	X	X	X	X				X	X	X	X	X	X	X	X	X
Oscillatoria					X		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
EUGLENOPHYTA																																
Cryptoglena													X				X	X							X		X	X	X	X	X	X
Euglena					X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Phacus																									X	X	X	X	X	X	X	X
Trachelomonas	X	X	X	X		X		X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PYRROPHYTA																																
Ceratium				X										X		X			X			X					X	X	X	X	X	X
Glenodinium																	X									X	X	X		X		X
Gymnodinium	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X		X					X	X	X	X	X	X
Peridinium																	X										X			X		X

1 - CRM 14.4
2 - CRM 15.4
3 - CRM 17.9
4 - CRM 19.0
(Blank space indicates organism was not found)

Table B.1.2

STANDING CROP ESTIMATES AND PERCENT COMPOSITION

OF THE MAJOR PHYTOPLANKTON DIVISIONS WITHIN THE VICINITY OF

THE CRBRP PROJECT - CLINCH RIVER

MARCH 1975 THROUGH OCTOBER 1975

Date	Clinch River Mile	Major Algal Division	Standing Crop (No./L = $X10^6$)	Percent Composition
March 11, 1975	14.4	Chrysophyta	.046	45.9
		Chlorophyta	.002	2.0
		Cyanophyta	.043	42.7
		Euglenophyta	.002	1.6
		Pyrrophyta	.008	7.7
	15.4	Chrysophyta	.075	60.7
		Chlorophyta	.002	2.0
		Cyanophyta	.033	26.7
		Euglenophyta	.005	4.0
		Pyrrophyta	.008	6.7
	17.9	Chrysophyta	.062	62.5
		Chlorophyta	.006	5.8
		Cyanophyta	.020	20.2
		Euglenophyta	.002	2.5
		Pyrrophyta	.009	9.1
	19.0	Chrysophyta	.028	47.3
		Chlorophyta	.001	2.1
		Cyanophyta	.014	23.3
		Euglenophyta	.002	3.4
		Pyrrophyta	.014	24.0
April 16, 1975	14.4	Chrysophyta	.053	35.0
		Chlorophyta	.079	51.7
		Cyanophyta	.006	3.8
		Euglenophyta	.001	0.5
		Pyrrophyta	.014	9.0
	15.4	Chrysophyta	.030	19.8
		Chlorophyta	.093	60.8
		Cyanophyta	.005	3.1
		Euglenophyta	.006	4.1
		Pyrrophyta	.019	12.2
	17.9	Chrysophyta	.031	14.4
		Chlorophyta	.162	75.8
		Cyanophyta	.003	1.5
		Euglenophyta	.001	0.4
		Pyrrophyta	.017	8.0

Table B.1.2
(Continued)

Date	Clinch River Mile	Major Algal Division	Standing Crop (No./L = X10^6)	Percent Composition
April 16, 1975	19.0	Chrysophyta	.019	19.1
		Chlorophyta	.061	59.5
		Cyanophyta	.001	0.8
		Euglenophyta	.002	1.5
		Pyrrophyta	.019	19.1
May 22, 1975	14.4	Chrysophyta	.306	60.7
		Chlorophyta	.115	22.8
		Cyanophyta	.083	16.6
		Euglenophyta	.000	0
		Pyrrophyta	.000	0
	15.4	Chrysophyta	.364	50.8
		Chlorophyta	.202	28.1
		Cyanophyta	.150	20.8
		Euglenophyta	.0004	0.1
		Pyrrophyta	.002	0.2
	17.9	Chrysophyta	.293	37.9
		Chlorophyta	.341	44.2
		Cyanophyta	.134	17.3
		Euglenophyta	.003	0.4
		Pyrrophyta	.001	0.1
	19.0	Chrysophyta	.221	41.7
		Chlorophyta	.201	37.8
		Cyanophyta	.107	20.2
		Euglenophyta	.001	0.2
		Pyrrophyta	.001	0.2
June 18, 1975	14.4	Chrysophyta	.264	20.7
		Chlorophyta	.412	32.2
		Cyanophyta	.589	46.0
		Euglenophyta	.012	0.9
		Pyrrophyta	.003	0.2
	15.4	Chrysophyta	.213	18.2
		Chlorophyta	.338	28.9
		Cyanophyta	.595	50.9
		Euglenophyta	.019	1.7
		Pyrrophyta	.005	0.4

Table B.1.2
(Continued)

Date	Clinch River Mile	Major Algal Division	Standing Crop (No./L = X10^6)	Percent Composition
June 18, 1975	17.9	Chrysophyta	.151	12.0
		Chlorophyta	.387	30.7
		Cyanophyta	.694	55.1
		Euglenophyta	.023	1.9
		Pyrrophyta	.005	0.4
	19.0	Chrysophyta	.074	9.7
		Chlorophyta	.223	29.2
		Cyanophyta	.446	58.4
		Euglenophyta	.017	2.2
		Pyrrophyta	.004	0.6
July 15, 1975	14.4	Chrysophyta	.142	19.9
		Chlorophyta	.408	57.4
		Cyanophyta	.151	21.3
		Euglenophyta	.009	1.3
		Pyrrophyta	.001	0.1
	15.4	Chrysophyta	.156	20.3
		Chlorophyta	.403	52.3
		Cyanophyta	.201	26.2
		Euglenophyta	.008	1.0
		Pyrrophyta	.002	0.2
	17.9	Chrysophyta	.119	13.1
		Chlorophyta	.447	49.2
		Cyanophyta	.329	36.3
		Euglenophyta	.010	1.1
		Pyrrophyta	.003	0.3
	19.0	Chrysophyta	.153	18.0
		Chlorophyta	.369	43.2
		Cyanophyta	.316	37.0
		Euglenophyta	.015	1.7
		Pyrrophyta	.001	0.1
Aug. 7, 1975	14.4	Chrysophyta	.142	57.4
		Chlorophyta	.078	31.8
		Cyanophyta	.023	9.5
		Euglenophyta	.003	1.3
		Pyrrophyta	.000	0

Table B.1.2
(Continued)

Date	Clinch River Mile	Major Algal Division	Standing Crop (No./L = X10^{6})	Percent Composition
Aug. 7, 1975	15.4	Chrysophyta	.173	43.6
		Chlorophyta	1.308	34.9
		Cyanophyta	.076	19.1
		Euglenophyta	.009	2.2
		Pyrrophyta	.001	0.2
	17.9	Chrysophyta	.138	49.9
		Chlorophyta	.079	28.5
		Cyanophyta	.057	20.5
		Euglenophyta	.003	1.0
		Pyrrophyta	.000	0
	19.0	Chrysophyta	.144	30.7
		Chlorophyta	.208	44.3
		Cyanophyta	.113	24.1
		Euglenophyta	.004	0.9
		Pyrrophyta	.000	0
Sept. 16, 1975	14.4	Chrysophyta	.155	12.6
		Chlorophyta	.412	33.5
		Cyanophyta	.645	52.3
		Euglenophyta	.014	1.0
		Pyrrophyta	.007	1.0
	15.4	Chrysophyta	.140	14.4
		Chlorophyta	.309	31.7
		Cyanophyta	.513	52.7
		Euglenophyta	.010	1.0
		Pyrrophyta	.002	0.2
	17.9	Chrysophyta	.139	11.2
		Chlorophyta	.360	29.0
		Cyanophyta	.718	57.9
		Euglenophyta	.018	1.4
		Pyrrophyta	.006	0.5
	19.0	Chrysophyta	.139	18.1
		Chlorophyta	.312	40.7
		Cyanophyta	.291	37.9
		Euglenophyta	.021	2.7
		Pyrrophyta	.006	0.7

Table B.1.2
(Continued)

Date	Clinch River Mile	Major Algal Division	Standing Crop (No./L = X10^6)	Percent Composition
Oct. 15, 1975	14.4	Chrysophyta	.845	22.8
		Chlorophyta	1.216	32.8
		Cyanophyta	1.619	43.7
		Euglenophyta	.023	0.6
		Pyrrophyta	.002	0.1
	15.4	Chrysophyta	.565	21.4
		Chlorophyta	.820	31.1
		Cyanophyta	1.231	46.7
		Euglenophyta	.018	0.7
		Pyrrophyta	.003	0.1
	17.9	Chrysophyta	.549	27.9
		Chlorophyta	.636	32.3
		Cyanophyta	.744	37.8
		Euglenophyta	.036	1.8
		Pyrrophyta	.004	0.2
	19.0	Chrysophyta	.558	25.3
		Chlorophyta	.740	33.5
		Cyanophyta	.883	40.0
		Euglenophyta	.021	1.0
		Pyrrophyta	.003	0.1

Table B.1.3

PHYTOPLANKTON POPULATIONS BETWEEN STATIONS AND MONTHS

IN THE VICINITY OF THE CRBRP PROJECT

MARCH 1975 THROUGH OCTOBER 1975

CRM	March	April	May	June	July	August	September	October	$\bar{x}$	Mean deviation	Coefficient of variation
	Algal cells/liter x 10^6										
14.4	.101	.152	.594	1.280	.711	.247	1.233	3.706	.992		
15.4	.123	.153	.718	1.169	.769	.396	.974	2.637	.867		
17.9	.099	.214	.772	1.260	.908	.277	1.240	1.969	.842		
19.0	.060	.102	.532	.764	.854	.470	.768	2.205	.719	0.03	13.04%

Table B.1.4

CHLOROPHYLL A AT VARIOUS LOCATIONS AND DEPTHS ON THE CLINCH RIVER DURING 1975

FROM MARCH THROUGH OCTOBER IN THE VICINITY OF THE CRBRP PROJECT

CRM 14.4

Duplicate Samples Each Month

Mg chl "a"/m³ (1)

Depth (meters)	March		April		May		June		July		August		September		October		$\bar{X}$	Mean Deviation M.D.	Coefficient of Variation-C.V.
CRM 14.4																			
0.0	1.99	1.65	1.30	1.65	1.00	1.33	3.02	[illegible]	1.76	2.41	2.07	1.46	1.46	1.42	3.90	[illegible]			
1.0	2.25	2.30	1.61	1.64	1.04	1.04	4.46	4.76	2.41	2.07	2.41	2.07	1.77	1.42	3.25	[illegible]			
3.0	1.34	1.64	1.30	1.64	1.04	1.34	4.72	3.80	2.73	2.46	1.51	2.15	2.11	1.31	2.59	[illegible]			
5.0	2.30	1.61	1.00	1.61	1.04	1.04	3.46	3.76	2.76	2.76	1.81	2.07	1.46	1.77	2.90	[illegible]			
mg chl a/m² (2)	9.35	9.17	6.66	5.19	5.19	5.99	21.06	19.92	12.72	11.99	10.08	10.21	9.04	8.22	14.89	[illegible]	11.09		
CRM 15.4																			
0.0	1.65	0.95	1.34	1.30	1.04	1.04	3.72	3.11	2.07	1.76	1.31	2.11	1.46	1.77	1.90	1.90			
1.0	1.26	1.65	1.65	1.69	1.69	2.04	4.37	4.07	2.45	1.76	2.46	2.42	1.77	1.77	1.90	1.90			
3.0	1.61	1.30	1.30	1.34	0.70	1.04	3.72	3.73	2.34	2.03	2.42	2.11	1.42	1.77	2.25	1.90			
5.0	1.95	1.26	1.69	1.64	1.39	1.73	3.77	3.80	2.07	2.07	2.41	2.41	1.51	1.77	2.25	1.55			
mg chl a/m² (2)	7.87	6.87	7.44	7.52	5.84	7.39	19.63	15.92	11.47	9.65	11.85	11.32	8.02	8.83	10.53	9.14	10.14		
CRM 17.9																			
0.0	1.69	1.69	1.61	1.30	1.69	1.39	3.76	2.81	1.77	2.07	2.41	2.76	2.42	1.46	1.90	2.25			
1.0	1.69	1.69	1.30	1.65	1.00	1.34	3.76	3.42	1.46	1.76	2.42	2.11	1.46	2.89	2.55	2.55			
3.0	1.96	1.69	1.65	1.65	1.65	1.99	2.77	3.07	2.68	2.72	2.42	3.07	1.85	1.12	2.90	2.55			
5.0	1.99	1.95	1.30	1.00	1.04	1.39	3.72	4.11	2.07	2.07	2.41	2.42	2.11	1.46	2.51	2.55			
mg chl a/m² (2)	9.28	8.71	7.35	7.42	6.68	9.08	16.79	15.77	10.50	11.20	12.09	13.11	9.21	8.77	13.08	12.53	10.73		
CRM 19.0																			
0.0	2.31	2.34	1.30	1.61	0.69	1.04	2.11	2.11	1.38	1.41	2.42	2.46	2.11	2.03	1.90	1.90			
1.0	1.68	1.95	1.61	1.30	1.74	0.70	3.15	2.72	2.38	2.07	2.41	2.11	1.81	1.77	2.24	2.55			
3.0	1.69	1.95	1.30	1.00	0.69	1.04	3.07	3.11	2.72	3.07	2.11	2.45	2.08	2.11	2.55	2.55			
5.0	1.34	2.00	0.99	1.30	1.04	1.34	2.76	3.07	1.38	2.42	2.12	2.45	1.77	1.77	2.55	2.55			
mg chl a/m² (2)	8.41	10.00	6.65	6.05	5.38	4.99	14.69	14.44	11.07	12.36	11.17	11.76	9.69	9.66	11.96	12.42	10.04	.59	4.76%

1 - Per Unit volume concentration
2 - Per Unit surface area concentration

Table B.1.5

PRIMARY PRODUCTIVITY (C-14) AT VARIOUS LOCATIONS AND DEPTHS ON THE CLINCH RIVER IN THE VICINITY OF THE CRBRP PROJECT DURING 1976 FROM MARCH THROUGH OCTOBER

Depth (meters)	March	April	May	June	July	August	September	October
	mg C/m^3/Hr							
	CRM 14.4 (Right Bank)							
0.0	11.44	29.67	14.52	37.81	28.60	27.02	23.86	61.10
1.0	5.21	27.37	20.40	44.33	18.40	22.78	17.74	50.53
3.0	0.92	8.41	10.60	11.90	3.81	6.86	3.90	14.84
mg C/m^2/day	90.14	544.32	318.98	871.10	550.78	433.80	351.86	1132.20
	CRM 14.4 (Channel)							
0.0	14.81	29.35	14.07	39.10	35.52	22.86	21.58	61.45
1.0	12.37	27.51	17.84	44.67	17.50	22.63	17.98	47.58
3.0	0.90	7.84	10.15	11.80	4.31	6.05	3.48	13.88
5.0	0.68	3.22	4.74	9.62	2.53	2.80	1.30	3.45
mg C/m^2/day	177.59	633.50	387.64	1072.45	665.52	479.34	381.67	1245.71
	CRM 14.4 (Left Bank)							
0.0	10.82	28.93	19.22	42.74	25.64	24.79	23.93	57.82
1.0	6.18	28.76	21.24	35.66	20.95	24.37	16.89	53.96
3.0	1.02	9.36	9.80	11.92	4.68	5.56	4.57	15.89
mg C/m^2/day	98.01	566.80	337.85	776.91	590.48	433.53	347.30	1174.93
	CRM 15.4 (Right Bank)							
0.0	20.51	22.96	18.13	31.80	22.99	23.62	19.48	42.32
1.0	7.97	23.15	18.52	32.77	17.16	23.41	16.18	39.15
3.0	1.32	6.48	9.06	11.18	4.78	5.52	4.74	10.85
mg C/m^2/day	146.85	445.96	302.50	682.51	507.07	416.99	321.33	847.81
	CRM 15.4 (Channel)							
0.0	20.91	24.81	17.09	31.78	24.35	24.25	17.93	39.76
1.0	3.87	22.29	16.97	32.20	19.32	23.40	14.03	41.75
3.0	0.68	6.33	9.38	11.35	3.50	5.45	4.40	11.26
5.0	1.01	2.97	3.83	3.62	3.16	1.92	1.93	4.48
mg C/m^2/day	116.26	520.36	372.80	810.32	619.37	477.38	337.88	1023.18

Table B.1.5
(Continued)

($mg\ C/m^3/Hr$)

Depth (meters)	March	April	May	June	July	August	September	October
				CRM 15.4 (Left Bank)				
0.0	20.25	24.69	16.91	27.00	21.40	25.49	18.27	42.08
1.0	7.60	21.40	16.56	31.80	17.06	21.47	15.18	39.14
3.0	1.45	7.28	8.23	12.47	2.42	4.87	4.29	12.88
$mg\ C/m^2/day$	142.70	437.91	273.61	659.49	467.22	396.11	300.12	865.48
				CRM 17.9 (Right Bank)				
0.0	13.14	19.48	16.33	26.57	21.52	19.36	14.56	41.41
1.0	4.68	19.45	17.47	27.25	14.63	21.79	13.50	36.74
3.0	0.64	5.88	8.06	5.86	1.69	5.44	3.96	10.82
$mg\ C/m^2/day$	88.79	379.16	279.54	537.39	415.16	380.15	261.08	809.46
				CRM 17.9 (Channel)				
0.0	14.48	19.45	16.15	26.42	22.95	29.34	19.50	42.75
1.0	5.73	16.52	16.55	26.22	17.62	26.24	14.78	40.96
3.0	0.73	4.99	8.03	6.75	1.40	5.66	4.56	13.12
5.0	0.65	2.43	3.48	1.67	0.81	3.17	2.35	5.19
$mg\ C/m^2/day$	112.02	397.15	345.15	606.21	501.01	544.88	359.85	1067.42
				CRM 17.9 (Left Bank)				
0.0	14.07	17.66	15.57	19.91	19.94	28.69	14.05	30.11
1.0	4.66	17.92	16.50	23.44	19.07	25.22	14.52	38.93
3.0	1.03	6.47	9.25	7.40	2.04	5.67	5.43	13.40
$mg\ C/m^2/day$	94.00	357.04	275.30	470.24	490.18	459.97	283.95	811.44

Table B.1.6

PRIMARY PRODUCTIVITY (C-14) AT VARIOUS LOCATIONS AND DEPTHS
ON THE CLINCH RIVER IN THE VICINITY OF THE CRBRP PROJECT
DURING 1977 FROM MARCH THROUGH OCTOBER

Depth (meters)	March	April	May	June	July	August	September	October
	mg $C/m^3/Hr$							
	CRM 14.4 (Right Bank)							
0.0	12.46	13.15	29.36	22.32	59.35	66.74		53.40
1.0	20.29	1.48	33.15	27.56	58.87	36.29		54.48
3.0		1.96	9.01	3.45	16.25	3.30		8.19
5.0								
mg C/m^2/day	99.66	85.50	595.96	427.16	1090.75	750.28		867.55
	CRM 14.4 (Channel)							
0.0	14.77	7.99	37.38	32.23	37.90	40.36		54.63
1.0	16.55	0.61	46.08	29.36	46.60	46.06		38.32
3.0	3.55	0.25	10.37	2.56	16.26	2.67		8.96
5.0	0.70	0.25	4.02	1.41	9.27	2.23		4.08
mg C/m^2/day	243.50	44.95	913.82	509.08	1061.58	797.41		794.50
	CRM 14.4 (Left Bank)							
0.0	8.60	7.32	31.50	34.81	26.73	1.34		68.53
1.0	20.56	1.51	34.38	27.64	36.58	13.42		72.64
3.0	5.88	0.75	19.87	1.76	20.86	2.73		8.73
5.0								
mg C/m^2/day	249.69	53.04	707.73	462.87	724.01	193.68		1130.51
	CRM 15.4 (Right Bank)							
0.0	9.70	8.37	29.84	28.35	33.71	20.93		46.87
1.0	11.88	0.79	30.33	35.02	38.44	22.36		29.16
3.0	4.42	0.28	4.05	4.36	5.97	3.59		5.57
mg C/m^2/day	164.88	44.93	523.22	542.46	654.02	391.89		541.11
	CRM 15.4 (Channel)							
0.0	9.01	7.85	27.42	24.82	46.81	26.28		41.80
1.0	13.89	1.21	33.95	24.73	42.09	20.58		42.12
3.0	4.08	0.35	9.84	3.25	6.68	3.95		4.80
5.0	1.33	0.76	3.20	2.98	5.52	2.40		3.68
mg C/m^2/day	211.87	57.32	710.38	450.35	856.48	447.25		724.33

Table B.1.6
(Continued)

mg $C/m^3/Hr$

Depth (meters)	March	April	May	June	July	August	September	October
				CRM 15.4 (Left Bank)				
0.0	8.81	8.65	29.30	25.35	48.62	44.10		55.01
1.0	17.74	1.80	25.40	28.06	56.11	20.57		37.59
3.0	4.51	0.82	4.55	2.76	7.86	1.21		2.18
mg $C/m^2/day$	216.16	62.42	465.14	439.14	945.28	445.61		640.29
				CRM 17.9 (Right Bank)				
0.0	13.62	12.93	36.77		62.08	35.73		37.67
1.0	14.22	1.67	42.39		47.62	35.99		34.95
3.0	4.38	0.85	10.52		8.16	2.44		8.02
mg $C/m^2/day$	197.90	78.15	750.72		898.87	611.75		589.90
				CRM 17.9 (Channel)				
0.0	5.91	12.17	41.26		59.53	43.55		36.59
1.0	8.51	1.29	31.33		43.46	40.32		40.76
3.0	3.16	0.99	7.46		6.48	3.68		8.33
5.0	0.90	0.20	0.94		3.87	3.10		2.33
mg $C/m^2/day$	139.53	81.11	677.64		908.35	763.35		732.22
				CRM 17.9 (Left Bank)				
0.0	19.93	13.29	35.69		47.66	29.63		51.11
1.0	10.13	1.30	36.03		44.63	21.36		37.21
3.0	6.12	0.61	12.45		6.00	1.10		6.78
mg $C/m^2/day$	190.31	73.16	684.64		786.36	394.82		655.81

Table B.2.1

Zooplankton Abundance in the Vicinity of the Proposed CRBRP, Clinch River - 1975

(numbers x $10^3/m^3$) (Average of duplicate samples)

	March				April				May				June			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
ROTIFERA																
Asplanchna amphora	0.0	0.0	<0.1	<0.1	0.0	<0.1	<0.1	0.0	1.8	2.3	1.6	1.2	0.3	0.1	0.2	<0.1
A. herricki	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.2	25.0	15.5	12.8	0.2	0.4	0.2	0.2
A. priodonta	0.3	0.2	0.5	0.4	0.5	0.6	0.7	0.7	5.4	4.6	3.2	2.0	0.0	0.0	0.0	0.0
Brachionus angularis	0.2	<0.1	<0.1	0.6	<0.1	<0.1	0.0	0.0	0.2	0.2	0.7	0.6	1.8	0.7	3.7	0.6
B. bidentata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1	0.0
B. budapestinensis	<0.1	0.0	0.2	0.2	<0.1	<0.1	<0.1	0.0	0.0	0.0	0.0	0.1	1.9	1.2	2.1	1.7
B. calyciflorus	<0.1	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.7	2.0	0.9	<0.1	<0.1	0.4	0.1
B. caudatus	0.3	<0.1	<0.1	0.4	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1	2.4	1.1
B. havanaensis	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B. quadridentatus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1	<0.1	0.0
B. rubens	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0
Cephalodella spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	<0.1	0.0	0.0	0.0	0.0	<0.1
Collotheca spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.1	<0.1	<0.1	<0.1	0.1
C. pelagica	<0.1	0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Conochiloides spp.	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	1.2	0.2	0.1	0.0	<0.1	0.2	0.4	0.1
Conochilus unicornis	<0.1	0.0	0.0	<0.1	0.0	<0.1	0.1	<0.1	38.1	36.4	32.1	23.8	0.0	<0.1	<0.1	0.1
Epiphanes macrourus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	3.7	3.5	0.0	0.0	0.0	0.0
Euchlanis spp.	<0.1	0.0	0.0	0.0	0.0	<0.1	<0.1	<0.1	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.0
Filinia spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.0
F. longiseta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0
F. maior	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.2	0.0	0.0	0.0	0.0	0.0
Gastropus spp	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	4.5	1.4	2.8	1.9
Hexarthra spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H. fennica	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H. mira	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H. mollis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1	0.0
Kellicottia bostoniensis	<0.1	<0.1	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
K. longispina	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
Keratella americana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
K. cochlearis	<0.1	0.0	<0.1	0.5	<0.1	0.0	<0.1	0.0	0.7	0.4	0.2	0.5	<0.1	0.2	1.1	0.2
K. crassa	0.5	0.3	0.4	0.5	<0.1	<0.1	<0.1	<0.1	1.7	0.3	1.5	1.2	0.0	0.3	0.2	0.2
K. earlinae	0.3	0.2	0.6	0.6	<0.1	0.1	0.3	0.1	8.0	7.0	8.0	7.9	0.0	0.8	1.2	1.4
Lecane spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1	0.0	0.0
Macrochaetus spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monostyla spp.	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	<0.1	0.0	<0.1	<0.1
M. quadridentata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Platyias patulus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0
Ploesoma hudsoni	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P. truncatum	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1	0.0	0.3	0.0	0.8	0.8	2.7	2.7	1.7	0.9
Polyarthra spp.	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.0	0.0	21.5	14.6	10.2	10.0	0.5	0.9	0.4	0.4
Rotaria spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1
R. neptunia	<0.1	<0.1	<0.1	<0.1	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Synchaeta spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.9	0.0	5.1	0.0	0.0	0.0	0.0
S. stylata	3.5	0.9	3.7	5.3	0.9	1.0	0.8	0.7	38.4	19.7	33.4	37.8	2.2	3.0	3.7	3.0
Trichocerca spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.2	<0.1	0.2	0.1	0.2
Trichotria spp.	<0.1	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0

Table B.2.1 (Continued)

	March 1	March 2	March 3	March 4	April 1	April 2	April 3	April 4	May 1	May 2	May 3	May 4	June 1	June 2	June 3	June 4
CLADOCERA																
Alona costata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1	<0.1	0.0
A. rectangula	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1
Bosmina longirostris	0.9	0.4	0.9	0.9	5.4	7.0	8.5	4.0	25.3	13.0	11.4	9.6	3.0	1.7	2.0	0.1
Camptocercus rectirostris	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ceriodaphnia spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. acanthina	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. lacustris	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1	<0.1	<0.1	<0.1
C. quadrangula	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. reticulata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chydorus spp.	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	<0.1	<0.1	0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1
Daphnia Imm.	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.9	0.2	0.6	0.5	<0.1	0.2	0.3	0.4
D. galeatmendota	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.0
D. parvula	0.0	0.0	<0.1	<0.1	<0.1	<0.1	<0.1	0.0	<0.1	<0.1	<0.1	<0.1	0.0	0.0	0.0	0.0
D. pulex	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1	<0.1	<0.1
D. retrocurva	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	<0.1	0.3	0.3	0.4	0.2	0.3	0.1
Diaphanosoma leuchtenbergianum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.2	0.1	<0.1	1.0	0.3	0.2	0.1
Ilyocryptus spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I. spinifer	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Leptodora kindtii	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1	<0.1	0.2	0.1	<0.1	0.1	<0.1
Moina spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
M. micrura	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
M. minuta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pleuroxus spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P. denticulatus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1	0.0
P. hamulatus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Scapholebris kingi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1	0.0	0.0	0.0	0.0	0.0	0.0
Sida crystallina	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.0
COPEPODA																
Calanoida	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	0.1	0.2	<0.1	<0.1	<0.1	<0.0	<0.0
Cyclopoida	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.2	0.1	0.9	0.7	1.0	0.4	0.3	0.3	0.2	0.2
Cyclops varicans rubellus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1	<0.1	<0.1	0.0	0.0	0.0	0.0
C. bicuspidatus thomasi	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	0.3	0.1	0.6	<0.1	<0.1	<0.1	<0.1	<0.1
C. vernalis	0.0	0.0	0.0	0.0	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
Diaptomus mississippiensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0
D. pallidus	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.0	<0.1
D. reighardi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0
D. sanguineus	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.0	0.0	0.0	<0.1
Elaphoidella bidens coronata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ergasilus spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eucyclops agilis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Harpacticoida	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1
Macrocyclops albidus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.0
Mesocyclops edax	0.0	0.0	0.0	0.0	<0.1	<0.1	<0.1	0.0	<0.1	<0.1	0.1	0.0	<0.1	<0.1	<0.1	<0.1
Nauplii	0.6	0.3	0.8	0.7	1.5	2.2	4.3	2.8	3.1	2.3	2.4	3.1	1.4	1.5	1.1	1.0
Nitrocra lacustris	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Paracyclops fimbriatus poppei	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tropocyclops prasinus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1	0.0	0.0	0.0	0.0	0.0

Note: 1 - CRM 14.4
2 - CRM 15.4
3 - CRM 17.9
4 - CRM 19.0

Table B.2.1 (Continued)

	July				August				September				October			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
ROTIFERA																
Asplanchna amphora	1.7	0.7	1.1	0.4	0.3	0.5	2.0	0.8	1.0	0.9	1.7	1.5	3.0	0.8	1.2	1.6
A. herricki	5.6	3.5	4.9	6.0	0.4	0.8	2.4	0.8	0.4	0.8	0.6	0.3	21.6	12.1	31.2	40.7
A. priodonta	0.0	0.0	0.0	<0.1	1.7	0.8	0.3	0.0	0.4	0.6	0.5	0.7	<0.1	<0.1	1.0	1.2
Brachionus angularis	5.1	4.8	6.0	4.7	0.4	0.6	1.0	1.0	0.5	0.6	1.0	0.9	0.3	<0.1	0.2	0.3
B. bidentata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1
B. budapestinensis	3.2	3.8	2.0	2.9	1.8	3.6	4.0	4.0	2.2	2.3	2.7	2.7	0.3	0.8	0.5	1.0
B. calyciflorus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.9	1.0	0.3	0.2
B. caudatus	0.0	0.0	2.4	0.6	0.2	<0.1	0.1	0.4	0.0	<0.1	<0.1	0.0	0.1	0.0	0.0	0.0
B. havanaensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B. quadridentatus	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B. rubens	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cephalodella spp.	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	<0.1	<0.1	0.0	0.0	0.0	0.0	<0.1	<0.1
Collotheca spp.	0.1	<0.1	0.2	<0.1	<0.1	0.1	0.0	0.0	0.8	0.6	0.5	1.0	1.0	1.5	2.0	3.4
C. pelagica	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Conochiloides spp.	1.4	1.7	1.8	0.7	0.3	0.8	1.1	1.0	4.2	3.8	4.0	4.6	0.0	0.2	0.4	<0.1
Conochilus unicornis	17.9	5.9	13.4	3.0	22.2	8.4	55.5	31.5	13.8	11.9	14.9	20.5	1.2	0.9	0.7	0.9
Epiphanes macrourus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Euchlanis spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.0
Filinia spp.	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.0
F. longiseta	<0.1	0.3	0.2	0.6	0.2	0.4	0.3	0.2	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.0
F. maior	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gastropus spp.	16.0	9.7	6.3	5.7	3.2	2.1	5.8	3.0	0.8	2.4	1.4	3.5	1.6	1.5	2.2	3.6
Hexarthra spp.	0.0	0.0	0.0	0.0	<0.1	<0.1	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H. fennica	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H. mira	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H. mollis	0.0	0.0	<0.1	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Kellicottia bostoniensis	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1	<0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
K. longispina	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Keratella americana	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
K. cochlearis	1.1	0.6	0.6	0.2	1.0	0.9	1.4	0.8	1.8	1.3	2.0	1.4	0.4	0.3	0.1	0.1
K. crassa	4.1	1.1	<0.1	0.1	0.1	0.1	<0.1	<0.1	0.5	0.6	0.9	0.7	2.3	2.0	1.9	3.5
K. earlinae	7.7	5.1	8.1	3.9	3.2	5.7	8.5	5.8	10.2	13.3	15.2	11.6	16.4	14.8	16.6	27.0
Lecane spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Macrochaetus spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1
Monostyla spp.	0.0	0.0	<0.1	0.0	0.0	<0.1	0.2	<0.1	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	<0.1
M. quadridentata	0.0	0.0	0.0	0.0	0.0	0.0	0.3	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Platyias patulus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ploesoma hudsoni	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	<0.1	<0.1	0.0	0.0	0.0	0.0
P. truncatum	6.3	10.1	6.7	8.5	1.0	4.3	2.3	2.2	3.4	3.1	3.4	2.2	0.4	<0.1	0.4	0.7
Polyarthra spp.	5.4	1.2	3.0	2.4	1.6	0.8	1.0	4.2	6.4	3.2	5.4	2.7	59.2	43.5	45.2	59.2
Rotaria spp.	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0
R. neptunia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Synchaeta spp.	0.0	0.0	0.0	0.0	5.8	2.8	2.4	2.0	2.3	4.4	1.3	2.0	0.0	0.5	0.0	0.0
S. stylata	26.9	14.9	19.3	25.4	11.6	16.6	12.4	14.3	0.0	0.0	0.0	0.0	5.3	1.1	2.4	11.4
Trichocerca spp.	0.6	0.4	0.3	0.2	0.6	0.4	0.9	0.6	0.7	0.7	0.5	0.5	0.2	0.0	0.1	0.5
Trichotria spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table B.2.1 (Continued)

	July 1	July 2	July 3	July 4	August 1	August 2	August 3	August 4	September 1	September 2	September 3	September 4	October 1	October 2	October 3	October 4
CLADOCERA																
Alona costata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. rectangula	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bosmina longirostris	1.7	1.0	2.1	1.5	1.1	0.9	4.6	3.2	2.8	3.0	3.3	3.2	0.6	0.5	1.0	0.2
Camptocercus rectirostris	0.0	0.0	<0.1	0.0	<0.1	0.2	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ceriodaphnia spp.	<0.1	0.2	<0.1	0.2	0.0	0.0	<0.1	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. acanthina	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. lacustris	0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.5	0.4	0.7	0.4	0.2	<0.1	<0.1	<0.1
C. quadrangula	0.0	0.0	<0.1	0.0	<0.1	<0.1	<0.1	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. reticulata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chydorus spp.	<0.1	0.0	<0.1	0.0	0.0	<0.1	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Daphnia Imm.	<0.1	0.2	0.2	<0.1	0.1	1.1	0.4	0.6	0.2	0.1	0.2	<0.1	<0.1	0.5	0.0	0.0
D. galeatmendota	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0
D. parvula	0.0	0.0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0
D. pulex	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D. retrocurva	0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1	<0.1	0.3	0.3	1.3	0.9	0.3	0.7	0.5	0.4
Diaphanosoma leuchtenbergianum	0.3	1.5	1.1	0.9	0.6	2.1	1.4	0.9	2.5	0.7	1.3	2.2	1.6	1.8	1.0	2.2
Ilyocryptus spp.	0.0	<0.1	0.0	0.0	<0.1	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I. spinifer	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1	<0.1	0.0	0.0	0.0	0.0	<0.1
Leptodora kindtii	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	0.1	<0.1	0.0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Moina spp.	0.0	<0.1	<0.1	0.0	<0.1	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
M. micrura	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
M. minuta	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pleuroxus spp.	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P. denticulatus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P. hamulatus	0.0	0.0	0.0	0.0	<0.1	<0.1	<0.1	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Scapholebris kingi	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sida crystallina	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.0	0.0	<0.1	<0.1	0.0	<0.1	0.0	0.0	<0.1	<0.1
COPEPODA																
Calanoida	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	0.2	0.2	1.0	<0.1	0.4
Cyclopoida	0.6	0.3	0.5	0.7	0.3	0.5	0.3	0.4	0.9	0.5	0.4	0.8	2.3	4.1	1.9	1.6
Cyclops varicans rubellus	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.0
C. bicuspidatus thomasi	0.0	0.0	0.0	0.0	<0.1	0.0	<0.1	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. vernalis	<0.1	<0.1	<0.1	0.1	<0.1	0.2	0.2	<0.1	0.3	<0.1	0.7	<0.1	1.6	4.2	0.6	0.4
Diaptomus mississippiensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D. pallidus	<0.1	0.0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1
D. reighardi	0.0	0.0	<0.1	0.0	0.0	<0.1	0.0	<0.1	0.0	<0.1	<0.1	0.0	0.0	0.0	<0.1	0.0
D. sanguineus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Elaphoidella bidens coronata	0.0	<0.1	0.0	0.0	0.0	<0.1	0.0	<0.1	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.0
Ergasilus spp.	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	<0.1	0.0	<0.1	0.0	0.0	0.0
Eucyclops agilis	0.0	0.0	0.0	<0.1	<0.1	0.0	<0.1	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Harpacticoida	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0
Macrocyclops albidus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mesocyclops edax	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	0.2	0.2	0.2	<0.1	<0.1
Nauplii	3.0	2.1	2.0	2.2	2.2	3.6	3.2	2.9	5.7	6.3	7.2	7.2	8.3	11.2	9.0	11.0
Nitrocra lacustris	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Paracyclops fimbriatus poppei	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tropocyclops prasinus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	<0.1	0.0	<0.1	0.0	<0.1	<0.1	<0.1

Note: 1 - CRM 14.4
2 - CRM 15.4
3 - CRM 17.9
4 - CRM 19.0

Table B.3.1

Benthic Macroinvertebrate Fauna Collected in the Vicinity of the Proposed CRBRP, Clinch River - 1975 (Ponar Grab Samples)

Station	Month	Taxa	No./m²				
			Σx	n	$\bar{x}$	Range	Standard Deviation
14.4	Mar.	Bryozoa	145	10	14.5	0-91	31.8
	11	Corbicula manilensis	90	10	9.0	0-36	15.3
		Cyrnellus fraternus	72	10	7.2	0-36	12.6
		Dicrotendipes	72	10	7.2	0-36	12.6
14.4	April	Bryozoa	454	10	45.4	0-218	79.0
	14	Corbicula manilensis	18	10	1.8	0-18	5.7
		Cyrnellus	109	10	10.9	0-109	34.4
		Dicrotendipes	235	10	23.5	0-127	39.2
14.4	May	Corbicula manilensis	90	10	9.0	0-54	17.5
	21	Cyrnellus fraternus	72	10	7.2	0.36	12.6
		Dicrotendipes	344	10	34.4	0-91	34.8
14.4	June	Corbicula manilensis	90	10	9.0	0-36	12.7
	17		90	10	9.0	0-36	12.7
14.4	July	Dicrotendipes	54	10	5.4	0.18	8.7
	7						
14.4	Aug.	Chironomus	126	10	12.6	0-54	20.9
	6	Corbicula manilensis	18	10	1.8	0-18	5.7
14.4	Sept.	Chironomus	182	10	18.2	0-91	34.4
	15	Corbicula manilensis	18	10	1.8	0-18	5.7

Table B.3.1 (Continued)

Station	Month	Taxa	No./m² ΣX	n	$\bar{X}$	Range	Standard Deviation
		Cyrnellus	18	10	1.8	0-18	5.7
14.4	Oct.	Chironomus	54	10	5.4	0-36	12.1
	14	Corbicula manilensis	108	10	10.8	0-36	15.2
		Limnodrilus claporedianus	91	10	9.1	0-91	28.8
15.4	Mar.	Bryozoa	73	10	7.3	0-73	23.1
	11	Corbicula manilensis	90	10	9.0	0-36	15.3
15.4	April	Corbicula manilensis	54	10	5.4	0-36	12.1
	14						
15.4	May	Corbicula manilensis	18	10	1.8	0-18	5.7
	21						
15.4	June	No organisms present					
	17						
15.4							
15.4	July	Corbicula manilensis	18	10	1.8	0-18	5.7
	7						
15.4	Aug.	Corbicula manilensis	18	10	1.8	0-18	5.7
	6						
15.4	Sept.	Chironomus	54	10	5.4	0-18	8.7
	15	Corbicula manilensis	109	10	10.9	0-91	28.7

Table B.3.1 (Continued)

Station	Month	Taxa	No./m^2 Σx	n	$\bar{x}$	Range	Standard Deviation
		Cyrnellus fraternus	18	10	1.8	0-18	5.7
15.4	Oct.	Corbicula manilensis	145	10	14.5	0-109	34.0
	14						
17.9	Mar.	Bryozoa	398	10	39.8	0-181	64.3
	11	Corbicula manilensis	18	10	1.8	0-18	5.6
		Cyrnellus fraternus	36	10	3.6	0-36	11.4
17.9	April	Corbicula manilensis	36	10	3.6	0-36	11.4
	14						
17.9	May	Corbicula manilensis	18	10	1.8	0-18	5.7
	21		126	10	12.6	0-36	17.1
			145	10	14.5	0-145	45.9
17.9	June	Corbicula manilensis	72	10	7.2	0-36	12.6
	17	Dicrotendipes	18	10	1.8	0-18	5.7
17.9	July	Corbicula manilensis	18	10	1.8	0-18	5.7
	7						
17.9	Aug.	Corbicula manilensis	18	10	1.8	0-18	5.7
	6						

Table B.3.1 (Continued)

Station	Month	Taxa	No./m2 Σx	n	x̄	Range	Standard Deviation
17.9	Sept.	Chironomus sp.	54	10	5.4	0-18	8.7
	15	Corbicula manilensis	489	10	48.9	18-109	29.9
		Dicrotendipes	18	10	1.8	0-18	5.7
		Pentaneura	18	10	1.8	0-18	5.7
		Tanytarsus	18	10	1.8	0-18	5.7
17.9	Oct.	Corbicula manilensis	18	10	1.8	0-18	5.7
	14						
19.0	Mar.	Corbicula manilensis	18	10	1.8	0-18	5.7
	11	Planariidae	18	10	1.8	0-18	5.7
19.0	April	Corbicula manilensis	54	10	5.4	0-36	12.1
	14						
19.0	May	Dicrotendipes	18	10	1.8	0-18	5.7
	21	Limnodrilus clarapedianus	272	10	27.2	0-163	58.7
19.0	June	Corbicula manilensis	36	10	3.6	0-18	7.6
	17	Dicrotendipes	90	10	9.0	0-36	12.7
		Limnodrilus clarapedianus	181	10	18.1	0-181	57.3
19.0	July	Corbicula manilensis	36	10	3.6	0-18	7.6
	7						

Table B.3.1 (Continued)

Station	Month	Taxa	No./m^2				
			ΣX	n	$\bar{X}$	Range	Standard Deviation
19.0	Aug.	Corbicula manilensis	54	10	5.4	0-18	8.7
	6						
19.0	Sept.	Chaoborus	18	10	1.8	0-18	5.7
	15	Chironomus	54	10	5.4	0-18	8.7
		Corbicula manilensis	326	10	32.6	0-127	45.1
		Limnodrilus clarapedianus	109	10	10.9	0-109	34.4
19.0	Oct.	Corbicula manilensis	54	10	5.4	0-18	8.7
	14						

Table B.3.2

Benthic Macroinvertebrate Fauna Collected in the Vicinity of the Proposed CRBRP, Clinch River - 1976 (Ponar Grab Samples)

Station	Month	Taxa	No./m2 Σx	n	$\bar{x}$	Range	Standard Deviation
14.4	Mar.	Corbicula manilensis	18	10	1.8	0-18	5.7
	8						
	May	Chironomus	36	10	3.6	0-18	7.6
14.4	8	Corbicula manilensis	182	10	18.2	0-91	38.4
14.4	July	Chaoborus	36	10	3.6	0-36	11.4
	13	Chironomus tentans	18	10	1.8	0-18	5.7
		Corbicula manilensis	18	10	1.8	0-18	5.7
		Dicrotendipes	18	10	1.8	0-18	5.7
14.4	Sept.	Corbicula manilensis	73	10	7.3	0-73	23.1
	8	Cura foremanii	18	10	1.8	0-18	5.7
		Cyrnellus fraternus	72	10	7.2	0-36	12.6
		Dicrotendipes	72	10	7.2	0-54	17.4
		Sialis	36	10	3.6	0-18	7.6
15.4	Mar.	No organisms present					
	8						
15.4	May	Corbicula manilensis	18	10	1.8	0-18	5.7
	8						
15.4	July	Chaoborus	72	10	7.2	0-36	12.6
	13	Corbicula manilensis	36	10	3.6	0-18	7.6

Table B.3.2 (Continued)

Station	Month	Taxa	No./m² Σx	n	$\bar{X}$	Range	Standard Deviation
		Sphaerium	72	10	7.2	0-36	15.2
15.4	Sept. 18	Corbicula manilensis	90	10	9.0	0-54	17.5
17.9	Mar. 8	Corbicula manilensis	36	10	3.6	0-36	11.4
17.9	May 6	No organisms present					
17.9	July 13	Chaoborus	36	10	3.6	0-18	7.6
		Corbicula manilensis	361	10	36.1	0-73	24.2
		Limnodrilus clarapedianus	18	10	1.8	0-18	5.7
17.9	Sept. 8	Chironomus	54	10	5.4	0-18	8.7
		Corbicula manilensis	254	10	25.4	0-73	28.8
		Cura foremanii	72	10	7.2	0-54	17.4
		Cyrnellus fraternus	18	10	1.8	0-18	5.7
19.0	Mar. 8	No organisms present					
19.0	May 8	Corbicula manilensis	36	10	3.6	0-18	7.6
		Hexagenia bilineata	18	10	1.8	0-18	5.7

Table B.3.2 (Continued)

Station	Month	Taxa	No./m^2 ΣX	n	$\bar{X}$	Range	Standard Deviation
		Parachironomus	18	10	1.8	0-18	5.7
19.0	July	Chaoborus	18	10	1.8	0-18	5.7
	13	Chironomus sp.	18	10	1.8	0-18	5.7
		Corbicula manilensis	181	10	18.1	0-73	22.7
19.0	Sept.	Corbicula manilensis	1413	10	141.3	0-471	168.6
	8	Cura foremanii	18	10	1.8	0-18	5.7
		Limnodrilus clarapedianus	91	10	9.1	0-73	23.2

Table B.3.3

Benthic Macroinvertebrate Fauna Collected in the Vicinity of the Proposed CRBRP, Clinch River - 1977 (Ponar Grab Samples)

Station	Month	Taxa	No./m² Σx	n	$\bar{x}$	Range	Standard Deviation
14.4	Mar.	Tanytarsus	36	10	3.6	0-36	11.4
	15	Xenochironomus	18	10	1.8	0-18	5.7
14.4	May	Corbicula manilensis	108	10	10.8	0-54	17.4
	9						
14.4	July	Chironomus	54	10	5.4	0-36	12.1
	14	Corbicula manilensis	108	10	10.8	0-36	15.2
14.4	Sept.	Caenis	18	10	1.8	0-18	5.7
	7	Corbicula manilensis	162	10	16.2	0-54	23.2
		Corixidae	18	10	1.8	0-18	5.7
		Cyrnellus fraternus	18	10	1.8	0-18	5.7
		Dicrotendipes	72	10	7.2	0-54	17.4
		Dugesia	54	10	5.4	0-36	12.3
		Procladius	18	10	1.8	0-18	5.7
		Psectrocladius	109	10	10.9	0-73	23.1
		Rheotanytarsus	18	10	1.8	0-18	5.7
15.4	Mar.	Corbicula manilensis	72	10	7.2	0-18	9.3
	15						
15.4	May	Corbicula manilensis	54	10	5.4	0-36	12.2
	9						

Table B.3.3 (Continued)

Station	Month	Taxa	No./m² Σx	n	$\bar{X}$	Range	Standard Deviation
15.4	July	No organisms present					
	14						
15.4	Sept.	No organisms present					
	7						
17.9	Mar.	Corbicula manilensis	90	10	9.0	0-18	9.5
	15	Cura foremanii	18	10	1.8	0-18	5.7
17.9	May	No organisms present					
	9						
17.9	July	Corbicula manilensis	199	10	19.9		
	14	Cura foremanii	54	10	5.4		
17.9	Sept.	Corbicula manilensis	91	10	9.1	0-73	23.2
	7	Cyrnellus fraternus	18	10	1.8	0-18	5.7
		Dicrotendipes	54	10	5.4	0-36	12.2
		Leptoceridae	18	10	1.8	0-18	5.7
		Limnodrilus	18	10	1.8	0-18	5.7
	Mar.	Corbicula manilensis	54	10	5.4	0-36	12.2
	15	Eriocerca	18	10	1.8	0-18	5.7
19.0	May	Corbicula manilensis	18	10	1.8	0-18	5.7

Table B.3.3 (Continued)

Station	Month	Taxa	No./m^2				
			Σx	n	$\overline{X}$	Range	Standard Deviation
	9	Quadrula postulosa	18	10	1.8	0-18	5.7
19.0	July	Corbicula manilensis	218	10	21.8	0-73	29.5
	14	Crangonyx	18	10	1.8	0-18	5.7
19.0	Sept.	Corbicula manilensis	634	10	63.4	0-163	62.4
	7	Limnodrilus	18	10	1.8	0-18	5.7

Table B.3.4

Benthic Macroinvertebrate Fauna Collected in
the Vicinity of the Proposed CRBRP, Clinch River - 1975
(Artificial Substrate Samples)

Station	Month	Taxa	No./m^2 ΣX	n	$\bar{X}$	Range	Standard Deviation
CRM 14.4	June	Ablabesmyia	2.00	3	.6667	0-1	0.57735
	14	Bryozoa	1.00	3	.3333	0-1	0.57735
		Corbicula manilensis	11.00	3	3.6667	0-9	4.72582
		Crangonyx	1.00	3	.3333	0-1	0.57735
		Cyrnellus	7.00	3	2.3333	0-6	3.21455
		Dicrotendipes	59.00	3	19.6667	12-26	7.09460
		Lirceus	1.00	3	0.3333	0-1	0.57735
		Stenonema	2.00	3	0.6667	0-1	0.57735
	July	Ablabesmyia	1.00	3	0.3333	0-1	0.57735
	21	Bryozoa	1.00	3	0.3333	0-1	0.57735
		Cambarus sp.	1.00	3	0.3333	0-1	0.57735
		Chironomus sp.	1.00	3	0.3333	0-1	0.57735
		Cyrnellus fraternus	1.00	3	0.3333	0-1	0.57735
		Dicrotendipes	30.00	3	10.0000	3-14	6.08276
		Limnodrilus	4.00	3	1.3333	0-4	2.30940
		Xenochironomus	2.00	3	0.6667	0-1	0.57735
	Aug.	Chironomus tentans	2.00	3	0.66667	0-1	0.57735
	6	Chironomus	8.00	3	2.66667	0-8	4.61880
		Dicrotendipes	13.00	3	4.33333	0-9	4.50925
		Pentaneura	2.00	3	0.66667	0-1	0.57735
	Sept.	Chironomus	22.00	3	7.33333	5-9	2.08167
	15	Corbicula manilensis	8.00	3	2.66667	1-4	1.52753
		Cura	5.00	3	1.66667	1-2	0.57735
		Cyrnellus fraternus	6.00	3	2.00000	1-3	1.00000
		Limnodrilus	10.00	3	3.33333	0-10	5.77350

Table B.3.4 (Continued)

Station	Month	Taxa	No./m² ΣX	n	X̄	Range	Standard Deviation
		Sphaerium	5.00	3	1.66667	1-2	0.57735
	Oct.	Branchiura	22.00	3	7.33333	0-12	6.42910
	14	Chironomus tentans	2.00	3	0.66667	0-1	0.57735
		Chironomus	9.00	3	3.00000	2-4	1.00000
		Cura	2.00	3	0.66667	0-1	0.57735
		Cyrnellus fraternus	2.00	3	0.66667	0-1	0.57735
		Dicrotendipes	2.00	3	0.66667	0-1	0.57735
		Hexagenia bilineata	3.00	3	1.00000	1-1	0.00000
		Procladius	1.00	3	0.33333	0-1	0.57735
		Stenonema	1.00	3	0.33333	0-1	0.57735
CRM 15.4	April	Limnodrilus	2.00	3	0.666667	0-2	1.1547
	14						
	May	Dicrotendipes	62.00	3	20.6667	11-39	15.8850
	21	Lirceus	1.00	3	0.3333	0-1	0.5774
		Stenonema	1.00	3	0.3333	0-1	0.5774
	June	Dicrotendipes	130.00	3	43.3333	28-74	26.5581
	17	Orconectes	1.00	3	0.3333	0-1	0.5774
	Aug.	Chironomus	1.00	3	0.33333	0-1	0.57735
	6	Corbicula manilensis	2.00	3	0.66667	0-2	1.15470
		Cyrnellus fraternus	1.00	3	0.33333	0-1	0.57735
		Dicrotendipes	25.00	3	8.33333	5-13	4.16333
		Pentaneura	1.00	3	0.33333	0-1	0.57735
	Sept.	Cheumatopsyche	2.00	3	0.66667	0-1	0.57735
	15	Chironomus	1.00	3	0.33333	0-1	0.57735
		Corbicula manilensis	22.00	3	7.33333	7-8	0.57735

Table B.3.4 (Continued)

Station	Month	Taxa	No./m² Σx	n	$\bar{x}$	Range	Standard Deviation
		Cyrnellus fraternus	6.00	3	2.00000	1-3	1.00000
		Stenonema	1.00	3	0.33333	0-1	0.57735
	Oct.	Caenis	1.00	3	0.33333	0-1	0.57735
	14	Cambarus	1.00	3	0.33333	0-1	0.57735
		Chironomus	3.00	3	1.00000	1-1	0.00000
		Corbicula manilensis	24.00	3	8.00000	6-10	2.00000
		Cura	19.00	3	6.33333	5-8	1.52753
		Stenonema	5.00	3	1.66667	1-3	1.15470
	Nov.	Ablabesmyia	1.00	3	0.33333	0-1	0.57735
	10	Chironomus tentans	2.00	3	0.66667	0-1	0.57735
		Chironomus	1.00	3	0.33333	0-1	0.57735
		Corbicula manilensis	1.00	3	0.33333	0-1	0.57735
		Hexagenia bilineata	4.00	3	1.33333	1-2	0.57735
		Procladius	1.00	3	0.33333	0-1	0.57735
CRM 17.9	April	Bryozoa	1.00	3	0.333333	0-1	0.57735
	14						
	May	Bryozoa	1.00	3	0.3333	0-1	0.57735
	15	Dicrotendipes	52.00	3	17.3333	16-19	1.52753
		Stenonema	3.00	3	1.0000	0-3	1.73205
	June	Bryozoa	5.00	3	1.6667	0-5	2.8868
	17	Cyrnellus fraternus	2.00	3	0.6667	0-1	0.5774
		Dicrotendipes	214.00	3	71.3333	38-114	38.8501
		Stenonema	1.00	3	0.3333	0-1	0.5774
	July	Chironomus	1.00	3	0.3333	0-1	0.57735
	14	Cyrnellus fraternus	1.00	3	0.3333	0-1	0.57735

Table B.34 (Continued)

Station	Month	Taxa	No./m^2 Σx	n	$\bar{X}$	Range	Standard Deviation
		Dicrotendipes	34.00	3	11.3333	4-17	6.65833
		Macromia	1.00	3	0.333	0-1	0.57735
		Stenonema	2.00	3	0.6667	0-2	1.15470
	Aug.	Argia sp.	2.00	3	0.6667	0-1	0.5774
	6	Chironomus tentans	2.00	3	0.6667	0-1	0.5774
		Chironomus	32.00	3	10.6667	4-23	10.6927
		Dicrotendipes	85.00	3	28.3333	15-50	18.9297
		Pentaneura	1.00	3	0.3333	0-1	0.5774
		Sphaerium	1.00	3	0.3333	0-1	0.5774
		Stenonema	2.00	3	0.666667	0-1	0.57735
	Sept.	Cheumatopsyche	3.00	3	1.00000	0-3	1.73205
	15	Chironomus sp.	19.00	3	6.33333	5-9	2.30940
		Corbicula manilensis	15.00	3	5.00000	4-6	1.00000
		Cyrnellus fraternus	5.00	3	1.66667	0-4	2.08167
		Pentaneura	2.00	3	0.66667	0-1	0.57735
		Stenonema	3.00	3	1.00000	0-2	1.0000
	Oct.	Chironomus	2.00	3	0.66667	0-1	0.57735
	14	Corbicula manilensis	11.00	3	3.66667	2-5	1.52753
		Cura	18.00	3	6.00000	3-9	3.00000
		Cyrnellus fraternus	1.00	3	0.33333	0-1	0.57735
		Stenonema	2.00	3	0.66667	0-1	0.57735
	Nov.	Ablabesmyia	1.00	3	0.3333	0-1	0.57735
	10	Branchiura	8.00	3	2.6667	0-8	4.61880
		Chironomus	35.00	3	11.6667	10-13	1.52753
		Corbicula manilensis	1.00	3	0.3333	0-1	0.57735

Table B.3.4 (Continued)

Station	Month	Taxa	No./m² Σx	n	x̄	Range	Standard Deviation
		Cura	5.00	3	1.6667	1-3	1.15470
		Dicrotendipes	12.00	3	4.0000	2-6	2.00000
		Stenonema sp.	1.00	3	0.3333	0-1	0.57735
CRM 19.0	April	Bryozoa	1.00	3	0.33333	0-1	0.57735
	14	Crangonyx	1.00	3	0.33333	0-1	0.57735
		Dicrotendipes	3.00	3	1.00000	1-1	0.00000
		Stenonema	2.00	3	0.66667	0-1	0.57735
	May	Bryozoa	1.00	3	0.3333	0-1	0.5774
	21	Corbicula manilensis	1.00	3	0.3333	0-1	0.5774
		Cyrnellus	2.00	3	0.6667	0-1	0.5774
		Dicrotendipes	62.00	3	20.6667	0-51	26.8390
		Hirudidae	1.00	3	0.3333	0-1	0.5774
		Limnodrilus	7.00	3	2.3333	0-7	4.0415
		Stenonema	2.00	3	0.6667	0-1	0.5774
	July	Bryozoa	1.00	3	0.3333	0-1	0.57735
	14	Cheumatopsyche	2.00	3	0.6667	0-1	0.57735
		Chironomus	4.00	3	1.3333	0-3	1.52753
		Dicrotendipes	46.00	3	15..3333	13-18	2.51661
		Stenonema	4.00	3	1.3333	1-2	0.57735
	Aug.	Chironomus tentans	9.00	3	3.00000	0-9	5.19615
	6	Chironomus	14.00	3	4.66667	4-5	0.57735
		Dicrotendipes	29.00	3	9.66667	0-18	9.07377
		Stenacron	1.00	3	0.33333	0-1	0.57735
		Stenonema	1.00	3	0.33333	0-1	0.57735
	Sept.	Chironomus	18.00	3	6.00000	4-8	2.00000

Table B.3.4 (Continued)

Station	Month	Taxa	No./m^2				
			ΣX	n	$\bar{X}$	Range	Standard Deviation
	15	Corbicula manilensis	17.00	3	5.66667	4-7	1.52753
		Cyrnellus fraternus	12.00	3	4.00000	2-6	2.00000
		Pentaneura	1.00	3	0.33333	0-1	0.57735
		Stenonema	1.00	3	0.33333	0-1	0.57735
	Oct.	Cambarus	1.00	3	0.3333	0-1	0.57735
	14	Chironomus	19.00	3	6.3333	5-8	1.52753
		Corbicula manilensis	6.00	3	2.0000	0-3	1.00000
		Cura	11.00	3	2.6667	2-5	1.52753
		Cyrnellus fraternus	26.00	3	8.6667	5-11	3.21455
		Stenonema	37.00	3	12.3333	10-15	2.51661
	Nov.	Branchiura	41.00	3	13.6667	0-23	12.0968
	10	Chironomus tentans	4.00	3	1.3333	1-2	0.5774
		Chironomus	13.0	6	2.1667	0-4	1.8348
		Corbicula manilensis	3.00	3	1.0000	1-1	0.0000
		Cyrnellus fraternus	1.00	3	0.3333	0-1	0.5774
		Dicrotendipes	8.00	3	2.6667	0-5	2.5166
		Hexagenia bilineata	4.00	3	1.3333	1-2	0.5774
		Limnodrilus	10.00	3	3.3333	0-10	5.7735
		Stenonema	1.00	3	0.3333	0-1	0.5774

Table B.3.5

Benthic Macroinvertebrate Fauna Collected in the Vicinity of the Proposed CRBRP, Clinch River - 1976 (Artificial Substrate Samples)

Station	Month	Taxa	No./m^2				
			ΣX	n	$\bar{X}$	Range	Standard Deviation
CRM 14.4	May	Chironomus	1.00	3	0.3333	0-1	0.5774
	5	Corbicula manilensis	8.00	3	2.6667	0-5	2.5166
		Cyrnellus fraternus	3.00	3	1.0000	0-2	1.0000
		Parachironomus	4.00	3	1.3333	0-2	1.1547
		Sida crystallina	109.00	3	36.3333	5-67	31.0054
		Stenonema tripunctatum	5.00	3	1.6667	0-4	2.0817
	July	Cambarus	2.00	3	0.667	0-2	1.1547
	13	Chironomus	17.00	3	5.667	2-9	3.5119
		Cura foremanii	35.00	3	11.667	0-24	12.0139
		Gammarus	1.00	3	0.333	0-1	0.5774
		Parachironomus	19.00	3	6.333	2-10	4.0415
		Pentaneura	2.00	3	0.667	0-1	0.5774
		Sida crystallina	1889.0	3	629.667	536-728	96.0850
		Stenonema	9.00	3	3.000	0-9	5.1962
	Sept.	Chironomus	13.00	3	4.3333	1-10	4.93288
	9	Cura foremanii	7.00	3	2.3333	0-4	2.08167
		Cyrnellus fraternus	14.00	3	4.6667	2-9	3.78594
		Parachironomus	4.00	3	1.3333	1-2	0.57735
		Pentaneura sp.E	1.00	3	0.3333	0-1	0.57735
		Sida crystallina	82.00	3	27.3333	19-35	8.02081
		Stenonema	10.00	3	3.3333	0-7	3.51188
	Nov.	Chironomus	40.00	3	13.3333	10-17	3.5119
	12	Corbicula manilensis	2.00	3	0.6667	0-1	0.5774
		Cura foremanii	47.00	3	15.6667	3-31	14.1892
		Cyrnellus	2.00	3	0.6667	0-1	0.5774

Table B.3 .5 (Continued)

Station	Month	Taxa	No./m^2				
			Σx	n	$\bar{x}$	Range	Standard Deviation
	Nov.	Dicrotendipes	5.00	3	1.6667	1-2	0.5774
	12	Hydra americana	51.00	3	17.0000	5-41	20.7846
		Limnodrilus claparedianus	5.00	3	1.6667	0-5	2.8868
		Neureclipsis	1.00	3	0.3333	0-1	0.5774
		Parachironomus	2.00	3	0.6667	0-2	1.1547
		Pentaneura sp.E	2.00	3	0.6667	0-2	1.1547
		Sida crystallina	12.00	3	4.0000	0-8	4.0000
		Stenonema	26.00	3	8.6667	5-14	4.7258
CRM 15.4	May	Corbicula manilensis	3.00	3	1.0000	0-3	1.73205
	5	Cryptochironomus	2.00	3	0.66667	0-1	0.57735
		Hydra americana	8.00	3	2.66667	0-8	4.61880
		Limnodrilus sp.1*	2.00	3	0.66667	0-2	1.15470
	July	Caenis simulans	1.00	3	0.3333	0-1	0.5774
	13	Cambarus	2.00	3	0.6667	0-1	0.5774
		Chironomus	4.00	3	1.3333	0-2	1.547
		Corbicula manilensis	21.00	3	7.0000	0-18	9.6437
		Cura foremanii	11.00	3	3.6667	0-6	3.2146
		Dicrotendipes	3.00	3	1.0000	0-3	1.7321
		Parachironomus	3.00	3	1.0000	0-3	1.7321
		Sida crystallina	177.00	3	59.0000	0-91	51.1566
		Stenonema	4.00	3	1.3333	0-3	1.5275
	Sept.	Branchiura sowerbyi	2.00	3	0.666667	0-2	1.15470
	9	Chironomus	1.00	3	0.333333	0-1	0.57735
		Corbicula manilensis	2.00	3	0.666667	0-2	1.15470
		Cyrnellus fraternus	2.00	3	0.666667	0-1	0.57735

Table B.3.5 (Continued)

Station	Month	Taxa	No./m^2 Σx	n	$\bar{x}$	Range	Standard Deviation
	Nov.	Corbicula manilensis	5.00	3	1.66667	0-4	2.08167
	12	Hydra americana	4.00	3	1.33333	1-2	0.57735
		Limnodrilus claparedianus	4.00	3	1.33333	0-2	1.15470
		Neureclipsis	1.00	3	0.33333	0-1	0.57735
CRM 17.9	May	Corbicula manilensis	2.00	3	0.6667	0-1	0.577
	5	Cyrnellus fraternus	3.00	3	1.0000	0-2	1.000
		Dicrotendipes	2.00	3	0.6667	0-2	1.155
		Hydra americana	257.00	3	85.6667	0-236	130.615
		Lirceus	1.00	3	0.3333	0-1	0.577
		Parachironomus	4.00	3	1.3333	1-2	0.577
		Sida crystallina	14.00	3	4.6667	0-14	8.083
		Stenonema	1.00	3	0.3333	0-1	0.577
	July	Cambarus	4.00	3	1.333	0-3	1.528
	13	Chironomus	8.00	3	2.667	2-4	1.155
		Corbicula manilensis	1.00	3	0.333	0-1	0.577
		Cura foremanii	19.00	3	6.333	3-12	4.933
		Gammarus	1.00	3	0.333	0-1	0.577
		Hirudinea	1.00	3	0.333	0-1	0.577
		Parachironomus	5.00	3	1.667	0-4	2.082
		Sida crystallina	2183.00	3	727.667	168-1150	505.199
		Stenonema	16.00	3	5.333	0-15	8.386
	Sept.	Chironomus	8.00	3	2.66667	1-6	2.88675
	9	Cura foremanii	6.00	3	2.00000	0-6	3.46410
		Cyrnellus fraternus	11.00	3	3.66667	1-7	3.05505
		Orconectes	1.00	3	0.33333	0-1	0.57735

Table B.3.5 (Continued)

Station	Month	Taxa	No./m² ΣX	n	$\bar{X}$	Range	Standard Deviation
	Sept.	Parachironomus	3.00	3	1.00000	1-1	0.00000
	9	Sida crystallina	10.00	3	3.33333	0-10	5.77350
		Stenonema	10.00	3	3.33333	0-7	3.51188
	Nov.	Chironomus	16.00	3	5.33	3-7	2.08
	11	Cura foremanii	50.01	3	16.67	10-21	5.86
		Cyrnellus fraternus	0.99	3	0.33	0-1	0.58
		Hydra americana	4329.99	3	1443.33	800-2670	1062.75
		Hydropsyche	0.99	3	0.33	0-1	0.58
		Stenonema	8.01	3	2.67	1-4	1.53
CRM 19.0	May	Chironomus	1.00	3	0.33333	0-1	0.57735
	5	Corbicula manilensis	2.00	3	0.66667	0-2	1.15470
		Cyrnellus fraternus	1.00	3	0.33333	0-1	0.57735
		Hydra americana	1.00	3	0.33333	0-1	0.57735
		Parachironomus	22.00	3	7.33333	5-12	4.04145
		Stenonema tripunctatum	1.00	3	0.33333	0-1	0.57735
	Sept.	Chironomus	3.00	3	1.0000	0-2	1.0000
	9	Cura foremanii	1.00	3	0.3333	0-1	0.5774
		Cyrnellus fraternus	8.00	3	2.6667	2-4	1.1547
		Hydropsyche	1.00	3	0.3333	0-1	0.5774
		Parachironomus	4.00	3	1.3333	0-3	1.5275
		Sida crystallina	64.00	3	21.3333	7-33	13.2035
		Stenonema	7.00	3	2.3333	1-4	1.5275
	Nov.	Chironomus	32.01	3	10.67	7-14	3.51
	12	Cura foremanii	45.00	3	15.00	13-17	2.00
		Cyrnellus fraternus	2.01	3	0.67	0-1	0.58

Table B.3.5 (Continued)

Station	Month	Taxa	No./m^2				
			Σx	n	$\bar{X}$	Range	Standard Deviation
		Hydra americana	3975.00	3	1325.00	225-2500	1139.35
		Hydropsyche	0.99	3	0.33	0-1	0.58
		Neureclipsis	0.99	3	0.33	0-1	0.58
		Stenonema	9.00	3	3.00	0-7	3.61

Table B.3.6

Benthic Macroinvertebrate Fauna Collected in
the Vicinity of the Proposed CRBRP, Clinch River - 1977
(Artificial Substrate Samples)

Station	Month	Taxa	No./m^2				
			Σx	n	$\bar{x}$	Range	Standard Deviation
CRM 14.4	Sept.	Ablabesmyia	6.00	3	2.0000	0-4	2.0000
	7	Agraylea	5.00	3	1.6667	1-3	1.1547
		Argia	2.00	3	0.6667	0-1	0.5774
		Cambarus	1.00	3	0.3333	0-1	0.5774
		Corbicula manilensis	3.00	3	1.0000	0-3	1.7321
		Crangonyx	4.00	3	1.3333	0-4	2.3094
		Cricotopus	9.00	3	3.0000	0-5	2.6458
		Cryptochironomus sp.	1.00	3	0.3333	0-1	0.5774
		Cyrnellus fraternus	19.00	3	6.3333	5-8	1.5275
		Dubiraphia	16.00	3	5.3333	4-7	1.5275
		Endochironomus	2.00	3	0.6667	0-2	1.1547
		Glyptotendipes	15.00	3	5.0000	0-8	4.3589
		Rheotanytarsus	20.00	3	6.6667	2-10	4.1633
		Sialis	1.00	3	0.3333	0-1	0.5774
		Sida Crystallina	97.00	3	32.3333	0-54	28.5365
		Stenacron	60.00	3	20.0000	2-53	28.6182
CRM 17.9	July	Ablabesmyia	1.00	3	0.33333	0-1	0.57735
	14	Chironomus	6.00	3	2.00000	1-3	1.00000
		Crangonyx	1.00	3	0.33333	0-1	0.57735
		Cura foremanii	5.00	3	1.66667	1-2	0-57735
		Hydroptila	7.00	3	2.33333	1-4	1.52753
		Lirceus	4.00	3	1.33333	0-3	1.52753
		Parachironomus	12.00	3	4.00000	3-6	1.73205
		Polycentropus	6.00	3	2.00000	0-6	3.46410
		Stenacron	4.00	3	1.33333	1-2	0.57735

Table B.3.6 (Continued)

Station	Month	Taxa	No./m^2				
			Σx	n	$\bar{x}$	Range	Standard Deviation
		Tricorythodes	1.00	3	0.33333	0-1	0.57735
CRM 17.9	Sept.	Agraylea	11.00	3	3.6667	1-8	3.7859
	7	Chironomus	2.00	3	0.6667	0-2	1.1547
		Corbicula manilensis	3.00	3	1.0000	0-3	1.7321
		Crangonyx	3.00	3	1.0000	0-3	1.7321
		Cricotopus	4.00	3	1.3333	0-4	2.3094
		Crynellus fraternus	60.00	3	20.0000	9-29	10.1489
		Dicrotendipes	10.00	3	3.3333	0-7	3.5119
		Lumbriculidae	2.00	3	0.6667	0-2	1.1547
		Pleurocera canaliculatum	1.00	3	0.3333	0-1	0.5774
		Psectrocladius	1.00	3	0.3333	0-1	0.5774
		Sida crystallina	19.00	3	6.3333	0-12	6.0277
		Sphaerium	1.00	3	0.3333	0-1	0.5774
		Stenacron	39.00	3	13.0000	8-18	5.0000
		Tubificidae	1.00	3	0.3333	0-1	0.5774
CRM 19.0	Sept.	Agraylea	4.00	3	1.3333	0-3	1.5275
	7	Corbicula manilensis	4.00	3	1.3333	0-4	2.3094
		Cyrnellus fraternus	25.00	3	8.3333	4-14	5.1316
		Dicrotendipes	28.00	3	9.3333	2-18	8.0829
		Dubiraphia	1.00	3	0.3333	0-1	0.5774
		Glyptotendipes	2.00	3	0.6667	0-2	1.1547
		Parachironomus	52.00	3	17.3333	11-24	6.5064
		Polypedilum	1.00	3	0.3333	0-1	0.5774
		Psectrocladius	1.00	3	0.3333	0-1	0.5774
		Rheotanytarsus	1.00	3	0.3333	0-1	0.5774

Table B.3.6 (Continued)

Station	Month	Taxa	No./m^2				
			Σx	n	$\bar{x}$	Range	Standard Deviation
		Sida crystallina	277.00	3	92.3333	64-142	43.1548
		Stenacron	17.00	3	5.6667	1-9	4.1633
CRM 19.0	Nov.	Agraylea	10.00	3	3.3333	0-9	4.9329
		Chironomidae	1.00	3	0.3333	0-1	0.5774
		Cricotopus	2.00	3	0.6667	0-2	1.1547
		Cyrnellus fraternus	1.00	3	0.3333	0-1	0.5774
		Dicrotendipes	35.00	3	11.6667	2-22	10.0167
		Dugesia tigrina	1.00	3	0.3333	0-1	0.5774
		Eukiefferiella	1.00	3	0.3333	0-1	0.5774
		Glyptotendipes	2.00	3	0.6667	0-2	1.1547
		Neureclipsis	4.00	3	1.3333	0-4	2.3094
		Polycentropus	9.00	3	3.0000	0-5	2.6458
		Psectrocladius	1.00	3	0.3333	0-1	0.5774
		Rheotanytarsus	1.00	3	0.3333	0-1	0.5774
		Simuliidae	1.00	3	0.3333	0-1	0.5774
		Xenochironomus	6.00	3	2.0000	0-5	2.6458

Appendix C

River Flow and Rainfall Data

TABLE C.1

DAILY DISCHARGES FROM MELTON HILL DAM (1975)

DISCHARGE IN DAY-SECOND-FEET

DAY	JANUARY TURBINE	JANUARY GATE	FEBRUARY TURBINE	FEBRUARY GATE	MARCH TURBINE	MARCH GATE	APRIL TURBINE	APRIL GATE	MAY TURBINE	MAY GATE	JUNE TURBINE	JUNE GATE
1	2,730	0	9,779	0	9,133	0	25,346	0	5,083	0	3,242	0
2	1,121	0	12,063	0	8,442	0	25,179	0	4,829	0	5,075	0
3	0	0	13,367	0	11,046	0	24,904	0	4,142	0	4,733	0
4	1,554	0	10,175	0	6,754	0	21,488	227	4,208	0	7,742	0
5	2,788	0	12,547	0	5,375	0	19,558	0	5,808	0	5,358	0
6	4,517	0	11,363	0	5,333	0	18,708	0	7,025	0	4,792	0
7	3,617	0	10,125	0	2,533	0	19,721	0	4,867	0	6,283	0
8	2,704	0	12,125	0	6,146	0	16,417	0	3,767	0	4,538	0
9	2,887	0	12,196	0	0	0	13,271	0	5,608	0	8,975	0
10	3,333	0	9,913	0	1,629	0	9,842	0	6,829	0	12,275	0
11	3,408	0	10,562	0	1,004	0	11,538	0	5,163	0	10,375	0
12	4,863	0	14,575	0	5,575	0	10,871	0	5,071	0	10,142	0
13	8,321	0	18,329	0	23,942	0	9,454	0	7,825	0	11,783	0
14	7,296	0	20,063	0	13,679	0	11,229	0	6,758	0	4,804	0
15	3,496	0	17,571	0	9,075	0	9,892	220	6,588	0	3,338	0
16	4,425	0	17,333	0	3,454	0	8,988	0	8,900	0	5,983	0
17	5,242	0	19,188	0	9,653	161	8,092	0	5,421	0	6,063	0
18	6,604	0	18,588	0	15,660	0	8,488	0	4,413	0	8,000	0
19	6,021	0	12,375	0	15,221	0	7,333	0	5,229	0	8,100	0
20	10,371	0	12,908	0	15,171	0	7,596	0	8,696	0	6,400	0
21	8,125	0	11,679	0	20,288	0	7,238	0	7,400	0	9,000	0
22	6,971	0	8,675	0	16,617	0	5,638	0	10,000	0	7,400	0
23	8,413	0	9,979	0	22,263	0	9,225	0	7,000	0	7,700	0
24	5,871	0	12,079	0	18,725	0	4,320	0	11,600	0	8,600	0
25	11,900	0	12,846	0	14,088	0	2,860	0	7,800	0	8,350	0
26	10,350	0	10,696	0	21,130	0	1,980	0	6,400	0	7,529	0
27	9,058	0	7,779	0	23,754	0	1,300	0	9,000	0	7,346	0
28	7,517	0	6,838	0	23,517	0	5,900	0	4,870	0	8,350	0
29	9,596	0			23,100	333	4,100	0	4,450	0	6,604	0
30	10,046	0			24,879	8,394	4,654	0	3,725	0	8,238	0
31	9,737	160			25,320	1,322			2,429	0		
TOTAL	186,882	160	355,661	0	402,503	10,210	335,130	447	190,904	0	217,118	0
AVERAGE	6,028	5	12,702	0	12,984	329	11,171	15	6,158	0	7,237	0

DAY	JULY TURBINE	JULY GATE	AUGUST TURBINE	AUGUST GATE	SEPTEMBER TURBINE	SEPTEMBER GATE	OCTOBER TURBINE	OCTOBER GATE	NOVEMBER TURBINE	NOVEMBER GATE	DECEMBER TURBINE	DECEMBER GATE
1	7,438	0	7,150	0	5,017	0	4,875	0	4,496	0	3,642	0
2	10,600	0	7,046	0	5,800	0	6,638	0	2,163	0	2,342	0
3	5,938	0	6,717	0	6,521	0	8,996	0	0	0	3,471	0
4	6,038	0	7,645	0	11,571	0	7,433	0	4,496	0	2,196	0
5	6,867	0	7,250	0	7,892	0	1,658	0	4,154	0	2,708	0
6	4,383	0	6,408	0	3,875	0	4,054	0	4,625	0	1,750	0
7	5,925	0	6,054	0	4,138	0	5,142	0	4,071	0	2,929	0
8	7,883	0	5,608	0	6,008	0	3,029	0	3,300	0	6,554	0
9	8,392	0	7,500	0	6,392	0	2,250	0	1,538	0	6,650	0
10	6,292	0	4,292	0	5,671	0	617	0	1,450	0	7,021	0
11	5,933	0	10,963	0	6,921	0	1,192	0	3,967	0	4,321	0
12	5,679	0	8,538	0	5,942	0	1,342	0	3,162	0	3,738	0
13	3,829	0	10,683	0	4,808	0	2,396	0	7,929	0	0	0
14	6,058	0	6,363	0	3,571	0	2,563	0	3,250	0	0	0
15	5,250	0	6,608	0	4,875	0	2,279	0	1,071	0	0	0
16	5,800	0	3,463	0	4,842	0	2,146	0	508	0	5,492	0
17	10,300	0	2,129	0	6,808	0	2,713	0	0	0	11,533	0
18	7,000	0	3,617	0	6,333	0	0	0	0	0	10,775	0
19	7,000	0	7,379	0	6,063	0	1,867	0	0	0	6,317	0
20	7,500	0	11,013	0	4,875	0	1,100	0	3,596	0	5,217	0
21	9,800	0	7,483	0	1,058	0	0	0	7,217	0	10,192	0
22	7,800	0	7,913	0	4,821	0	0	0	5,475	0	6,963	0
23	8,767	0	8,083	0	4,013	0	438	0	4,196	0	7,571	0
24	5,000	0	3,658	0	0	0	492	0	0	0	7,017	0
25	8,067	0	5,533	0	0	0	0	0	1,479	0	4,146	0
26	7,396	0	7,392	0	0	0	0	0	4,221	0	7,008	0
27	4,954	0	7,463	0	4,163	0	4,854	0	3,554	0	2,696	0
28	8,608	0	6,592	0	3,083	0	5,058	0	5,496	0	2,771	0
29	7,229	0	5,488	0	6,717	0	5,771	0	4,592	0	1,767	0
30	8,933	0	6,392	0	4,313	0	8,054	0	3,729	0	3,050	0
31	8,117	0	5,813	0			9,775	0			492	0
TOTAL	222,776	0	208,236	0	146,091	0	96,732	0	93,735	0	140,329	0
AVERAGE	7,186	0	6,717	0	4,870	0	3,120	0	3,125	0	4,527	0

	1974-1975 WATER YEAR DISCHARGE TOTAL	1974-1975 WATER YEAR DISCHARGE AVERAGE	1975 ANNUAL DISCHARGE TOTAL	1975 ANNUAL DISCHARGE AVERAGE
TURBINE	2,673,784	7,325	2,596,097	7,113
GATE	10,817	30	10,817	30
COMBINED	2,684,601	7,355	2,606,914	7,143

MAXIMUM DAILY AVERAGE DISCHARGE 33,273 ON MARCH 30.
MAXIMUM DAILY AVERAGE DISCHARGE SINCE FINAL CLOSURE (MAY 1, 1963) 34,966 ON JANUARY 11, 1974.
DISCHARGE DOES NOT INCLUDE LOCKAGE.

TABLE C.2

DAILY DISCHARGES FROM MELTON HILL DAM (1976)

DISCHARGE IN DAY-SECOND-FEET

DAY	JANUARY TURBINE	JANUARY GATE	FEBRUARY TURBINE	FEBRUARY GATE	MARCH TURBINE	MARCH GATE	APRIL TURBINE	APRIL GATE	MAY TURBINE	MAY GATE	JUNE TURBINE	JUNE GATE
1	2,521	0	2,996	0	3,542	0	3,725	0	3,267	0	833	0
2	5,025	0	13,846	0	5,604	0	2,588	0	620	0	1,379	0
3	2,533	0	6,029	0	7,388	0	5,425	0	3,663	0	2,508	0
4	4,713	0	2,621	0	7,638	0	4,100	0	3,646	0	1,742	0
5	4,875	0	670	0	4,867	0	6,942	0	3,808	0	858	0
6	6,188	0	850	0	6,183	0	8,079	0	3,517	0	738	0
7	4,367	0	5,512	0	0	0	4,725	0	3,313	0	1,513	0
8	6,100	0	3,217	0	8,067	0	3,233	0	2,900	0	1,379	0
9	9,108	0	6,229	0	4,521	0	4,475	0	2,279	0	721	0
10	7,592	0	3,550	0	5,121	0	2,371	0	3,192	0	1,196	0
11	6,983	0	5,554	0	3,829	0	0	0	3,329	0	2,313	0
12	6,167	0	5,979	0	4,050	0	5,638	0	2,204	0	1,688	0
13	8,683	0	4,667	0	3,154	0	5,625	0	2,379	0	0	0
14	12,554	0	0	0	2,579	0	5,275	0	1,033	0	6,429	0
15	11,300	0	0	0	3,667	0	4,363	0	1,258	0	5,971	0
16	12,500	0	5,283	0	5,383	0	5,142	0	3,154	0	3,875	0
17	7,146	0	5,704	0	4,838	0	4,483	0	3,771	0	5,413	0
18	6,879	0	5,029	0	5,029	0	2,979	0	0	0	8,466	0
19	4,288	0	8,267	0	3,292	0	4,454	0	0	0	4,542	0
20	5,792	0	7,971	0	2,975	0	4,825	0	0	0	1,525	0
21	4,908	0	4,900	0	2,613	0	4,475	0	2,879	0	5,967	0
22	9,229	0	2,983	0	3,725	0	3,613	0	917	0	0	0
23	5,600	0	4,779	0	2,846	0	4,283	0	0	0	1,004	0
24	5,563	0	7,638	0	6,750	0	2,350	0	1,879	0	679	0
25	6,650	0	7,388	0	6,387	0	2,763	0	2,379	0	896	0
26	10,379	0	7,013	0	1,663	0	4,142	0	1,175	0	1,971	0
27	9,571	0	7,088	0	1,829	0	4,396	0	1,808	0	2,550	0
28	4,633	0	4,829	0	0	0	3,867	0	2,146	0	3,229	0
29	2,904	0	3,642	0	0	0	4,763	0	1,471	0	2,833	0
30	1,271	0			2,804	0	4,375	0	1,438	0	3,700	0
31	1,521	0			3,438	0			1,113	0		
TOTAL	200,243	0	144,234	0	123,982	0	127,474	0	64,536	0	75,918	0
AVERAGE	6,459	0	4,974	0	3,999	0	4,249	0	2,082	0	2,531	0

DAY	JULY TURBINE	JULY GATE	AUGUST TURBINE	AUGUST GATE	SEPTEMBER TURBINE	SEPTEMBER GATE	OCTOBER TURBINE	OCTOBER GATE	NOVEMBER TURBINE	NOVEMBER GATE	DECEMBER TURBINE	DECEMBER GATE
1	1,125	0	5,558	0	5,833	0	783	0	4,592	0	3,975	0
2	917	0	4,104	0	6,254	0	1,267	0	3,725	0	1,306	0
3	0	0	6,029	0	5,404	0	0	0	6,588	0	2,363	0
4	0	0	6,633	0	5,958	0	1,321	0	5,954	0	3,817	0
5	1,404	0	9,804	0	2,217	0	1,588	0	5,517	0	921	0
6	1,004	0	7,088	0	4,538	0	2,304	0	3,150	0	3,075	0
7	846	0	4,117	0	9,188	0	2,779	0	683	0	6,079	0
8	1,042	0	3,892	0	8,221	0	1,671	0	3,225	0	7,746	0
9	1,313	0	7,767	0	4,350	0	4,321	0	3,342	0	5,971	0
10	954	0	6,913	0	675	0	375	0	4,613	0	5,513	0
11	0	0	7,113	0	950	0	4,588	0	3,879	0	4,842	0
12	4,175	0	5,279	0	1,329	0	5,363	0	4,225	0	3,817	0
13	4,454	0	4,646	0	5,350	0	7,150	0	2,650	0	5,413	0
14	4,129	0	2,217	0	4,158	0	5,367	0	0	0	8,463	0
15	5,438	0	0	0	4,329	0	4,458	0	1,479	0	6,417	0
16	4,979	0	5,621	0	4,258	0	1,500	0	1,158	0	4,800	0
17	2,563	0	5,396	0	4,433	0	350	0	1,600	0	3,792	0
18	504	0	5,783	0	3,325	0	5,690	0	2,417	0	3,604	0
19	4,279	0	6,854	0	2,671	0	7,238	0	1,456	0	0	0
20	6,625	0	5,250	0	3,717	0	7,446	0	883	0	11,258	0
21	5,346	0	8,417	0	5,538	0	5,629	0	304	0	7,867	0
22	6,929	0	4,167	0	6,580	0	3,642	0	5,625	0	5,750	0
23	7,425	0	6,792	0	4,983	0	4,263	0	7,679	0	1,550	0
24	6,400	0	6,963	0	5,004	0	1,021	0	7,271	0	1,983	0
25	6,167	0	6,308	0	2,033	0	2,579	0	3,904	0	4,821	0
26	7,438	0	6,475	0	1,025	0	3,000	0	158	0	3,804	0
27	5,600	0	7,663	0	5,262	0	3,950	0	204	0	2,658	0
28	5,329	0	6,671	0	4,183	0	5,471	0	0	0	3,333	0
29	5,667	0	6,517	0	2,446	0	2,300	0	5,992	0	5,267	0
30	5,792	0	6,100	0	1,558	0	3,396	0	5,533	0	4,550	0
31	5,029	0	7,146	0			0	0			5,633	0
TOTAL	112,473	0	183,283	0	125,770	0	101,010	0	98,008	0	140,402	0
AVERAGE	3,628	0	5,912	0	4,192	0	3,258	0	3,267	0	4,529	0

	1975-1976 WATER YEAR DISCHARGE TOTAL	1975-1976 WATER YEAR DISCHARGE AVERAGE	1976 ANNUAL DISCHARGE TOTAL	1976 ANNUAL DISCHARGE AVERAGE
TURBINE	1,488,711	4,068	1,497,335	4,091
GATE	0	0	0	0
COMBINED	1,488,711	4,068	1,497,335	4,091

MAXIMUM DAILY AVERAGE DISCHARGE 13,846 ON FEBRUARY 2.
MAXIMUM DAILY AVERAGE DISCHARGE SINCE FINAL CLOSURE (MAY 1, 1963) 34,986 ON JANUARY 11, 1974
DISCHARGE DOES NOT INCLUDE LOCKAGE.

TABLE C.3

DAILY DISCHARGES FROM MELTON HILL DAM (1977)

DISCHARGE IN DAY-SECOND-FEET

DAY	JANUARY TURBINE	JANUARY GATE	FEBRUARY TURBINE	FEBRUARY GATE	MARCH TURBINE	MARCH GATE	APRIL TURBINE	APRIL GATE	MAY TURBINE	MAY GATE	JUNE TURBINE	JUNE GATE
1	6,338	0	5,308	0	2,346	0	2,696	0	2,450	0	4,400	0
2	4,938	0	4,350	0	1,071	0	2,071	0	6,558	0	5,800	0
3	6,288	0	108	0	0	0	3,892	0	6,267	0	6,321	0
4	6,871	0	3,296	0	692	0	17,292	8,302	7,100	0	4,700	0
5	6,200	0	1,963	0	671	0	21,792	8,907	6,788	0	4,546	0
6	6,958	0	4,271	0	696	0	13,104	0	7,271	0	6,596	0
7	9,504	0	6,313	0	971	0	13,600	0	5,742	0	5,433	0
8	7,479	0	6,921	0	0	0	16,408	0	5,769	0	5,713	0
9	4,925	0	5,871	0	0	0	12,138	0	5,438	0	4,758	0
10	7,363	0	3,792	0	1,467	0	8,696	0	7,100	0	5,450	0
11	6,938	0	3,992	0	600	0	13,208	0	7,300	0	3,813	0
12	4,013	0	4,517	0	2,421	0	9,504	0	6,470	0	2,262	0
13	2,788	0	4,608	0	6,038	0	12,417	0	6,508	0	3,908	0
14	558	0	5,283	0	4,321	0	11,271	0	2,663	0	5,417	0
15	0	0	8,100	0	729	0	10,567	225	1,300	0	7,150	0
16	3,600	0	6,017	0	363	0	10,954	0	3,804	0	6,304	0
17	6,908	0	6,292	0	996	0	10,858	0	3,483	0	5,438	0
18	6,092	0	5,779	0	725	0	10,708	0	2,667	0	6,446	0
19	11,675	0	2,171	0	3,508	0	11,379	0	3,563	0	4,996	0
20	5,908	0	358	0	408	0	9,929	228	4,288	0	5,938	0
21	6,540	0	4,958	0	1,892	0	10,342	0	3,433	0	5,617	0
22	4,875	0	4,783	0	4,617	0	10,500	225	2,800	0	4,283	0
23	4,321	0	3,508	0	7,958	0	3,717	0	7,054	0	4,850	0
24	7,746	0	4,079	0	2,954	0	0	0	9,388	0	5,971	0
25	5,279	0	0	0	2,192	0	1,988	0	7,796	0	3,775	0
26	3,192	0	0	0	0	0	6,967	0	7,067	0	1,442	0
27	4,996	0	0	0	0	0	9,288	0	7,483	0	6,879	0
28	10,479	0	3,433	0	0	0	7,829	0	4,871	0	6,121	0
29	9,796	0			0	0	6,[illegible]33	0	3,050	0	5,850	0
30	2,167	0			0	0	4,313	0	5,542	0	5,471	0
31	1,900	0			3,167	0			9,246	0		
TOTAL	176,635	0	110,071	0	50,803	0	283,461	17,887	170,259	0	157,548	0
AVERAGE	5,698	0	3,931	0	1,639	0	9,449	596	5,492	0	5,252	0

DAY	JULY TURBINE	JULY GATE	AUGUST TURBINE	AUGUST GATE	SEPTEMBER TURBINE	SEPTEMBER GATE	OCTOBER TURBINE	OCTOBER GATE	NOVEMBER TURBINE	NOVEMBER GATE	DECEMBER TURBINE	DECEMBER GATE
1	5,558	0	8,158	0	4,975	0	2,571	0	4,521	0	6,175	0
2	4,883	0	6,196	0	5,050	0	2,371	0	3,192	0	12,304	0
3	2,083	0	5,271	0	5,133	0	3,517	0	2,888	0	9,983	0
4	1,308	0	3,754	0	5,188	0	4,133	0	1,371	0	9,325	0
5	5,858	0	4,142	0	5,133	0	2,617	0	2,061	0	14,708	0
6	7,554	0	3,446	0	5,150	0	1,279	0	1,421	0	17,363	0
7	5,421	0	3,050	0	5,300	0	1,217	0	2,971	0	18,146	0
8	4,029	0	4,254	0	5,900	0	804	0	3,358	0	18,438	0
9	2,871	0	5,188	0	5,100	0	4,046	0	4,667	0	19,579	0
10	2,021	0	5,058	0	2,600	0	1,617	0	6,088	0	18,488	0
11	4,758	0	6,608	0	0	0	3,292	0	7,204	0	18,654	0
12	5,108	0	4,446	0	2,700	0	4,604	0	7,300	0	14,638	0
13	6,947	0	2,254	0	3,380	0	5,083	0	6,883	0	12,325	0
14	6,021	0	0	0	3,879	0	3,608	0	7,908	0	15,633	0
15	7,446	0	5,808	0	5,167	0	2,825	0	9,775	0	16,000	0
16	5,104	0	5,842	0	1,958	0	3,538	0	9,758	0	16,442	0
17	4,263	0	5,214	0	3,147	0	4,078	0	9,517	0	15,829	0
18	5,914	0	4,046	0	1,913	0	4,933	0	10,642	0	15,800	0
19	6,692	0	2,275	0	0	0	5,300	0	10,454	0	16,417	0
20	6,093	0	1,671	0	2,529	0	3,488	0	10,963	0	16,267	0
21	5,846	0	0	0	3,538	0	4,156	0	11,650	0	17,558	0
22	5,800	0	4,971	0	4,704	0	1,754	0	10,554	0	15,546	0
23	5,058	0	4,650	0	4,896	0	2,[illegible]	0	14,300	0	12,852	0
24	3,925	0	5,000	0	3,738	0	4,783	0	14,958	0	11,554	0
25	4,979	0	6,250	0	1,217	0	5,175	0	12,717	0	19,163	0
26	5,938	0	5,300	0	4,408	0	3,096	0	10,917	0	12,571	0
27	6,300	0	4,963	0	6,513	0	4,729	0	8,579	0	13,713	0
28	5,471	0	3,721	0	3,225	0	3,650	0	10,004	0	13,342	0
29	5,942	0	4,471	0	2,179	0	2,058	0	9,750	0	13,013	0
30	5,263	0	4,750	0	2,121	0	1,121	0	8,417	0	10,304	0
31	5,913	0	5,775	0			4,008	0			9,838	0
TOTAL	162,381	0	137,339	0	110,736	0	102,346	0	234,718	0	452,008	0
AVERAGE	5,238	0	4,430	0	3,691	0	3,301	0	7,824	0	14,581	0

	1976-1977 WATER YEAR DISCHARGE TOTAL	1976-1977 WATER YEAR DISCHARGE AVERAGE	1977 ANNUAL DISCHARGE TOTAL	1977 ANNUAL DISCHARGE AVERAGE
TURBINE	1,698,653	4,654	2,148,305	5,886
GATE	17,887	49	17,887	49
COMBINED	1,716,540	4,703	2,166,192	5,935

MAXIMUM DAILY AVERAGE DISCHARGE 30,693 ON APRIL 5.
MAXIMUM DAILY AVERAGE DISCHARGE SINCE FINAL CLOSURE (MAY 1, 1963) [illegible] ON JANUARY 11, 1974.
DISCHARGE DOES NOT INCLUDE LOCKAGE

TABLE C.4

DAILY PRECIPITATION AT MELTON HILL DAM*

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	1975											
1	0.14	0.02	0.00	0.00	0.16	0.45	0.00	0.00	T	0.00	0.00	0.74
2	0.02	0.96	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00	0.00
3	0.00	0.58	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.91	0.95	0.00	0.00	0.07	0.00	0.00	1.23	0.00	0.00	0.00	0.00
5	0.00	0.87	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
6	0.00	0.15	0.00	0.00	0.00	0.79	0.18	0.00	0.04	0.00	0.00	0.00
7	0.00	0.11	0.00	0.00	0.22	0.00	0.00	0.02+	0.34	T	0.37	0.30
8	0.00	0.00	1.44	0.00	0.64	0.00	0.00	0.00	0.47	0.20	0.22	0.00
9	0.20	0.00	0.00	0.00	0.10	0.00	0.00	T	0.00	1.59++	0.00	0.33
10	0.05	0.00	0.00	0.05	0.00	0.87	0.00	0.12	0.00	0.00	0.07	0.22
11	0.95	0.05	0.36+	0.00	0.00	0.40	0.02	0.37	0.00	0.00	0.05	0.00
12	0.00	0.90	0.00	0.00	0.11	0.68++	0.00	0.00	0.11	0.02	1.22	0.00
13	0.65	0.00	2.85	0.00	0.17	0.10	0.04	0.00	T	0.00	0.75	0.00
14	0.19	0.00	1.96	T	0.00	0.22	0.00	0.00	0.00	0.00	T	0.00
15	0.00	0.00	0.00	0.34	0.14	0.00	0.17+	0.04	0.00	0.00+	0.00	0.00
16	0.00	0.15	0.02	0.00+	2.66++	0.17	0.00	0.00	0.00+	0.00	0.00	0.79
17	0.00	0.69	0.13	0.02	0.00	T	0.00	T	0.10	1.63	0.00	0.00
18	0.03	0.00	0.00	0.00	0.29	0.00+	0.00	0.20	1.76	0.73	0.00	0.00
19	0.31	0.12	0.31	0.00	0.00	0.00	0.00	T	T	0.06	0.00	0.00
20	0.95	0.05	0.12	0.65	0.00	0.00	T	0.00	0.03	0.00	0.00	0.00
21	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.68	0.00	0.30	0.00
22	0.00	0.00	0.00	0.00	0.00+	0.00	0.00	0.00	0.07	0.00	0.00	0.00
23	0.00	0.15	0.51	0.00	0.00	0.17	0.00	0.00	1.19	0.00	0.00	0.00
24	0.00	1.20	1.05	0.05	0.00	0.00	0.00	0.00	2.04++	0.00	0.00	0.00
25	1.58	0.00	0.46	T	0.00	0.00	T	0.00	0.05	0.00	0.00	0.16
26	0.10	0.00	0.00	0.42	0.00	0.80	0.10	0.00	0.00	0.00	0.00	1.46
27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.11	0.00
28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	T
29	0.00	X	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	0.20	X	3.28	0.00	0.42	0.00	0.02	0.00	0.00	0.14	0.00	0.12
31	0.00	X	0.00++	X	1.11	X	0.85	0.00	X	0.00	X	1.05
Total	6.28	6.95	13.28	1.78	6.09	4.70	1.40	2.00	6.88	5.50	3.09	5.17
Snow												

TABLE C.4
(Continued)

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	1976											
1	0.62	0.18	0.00	0.10	0.61	0.00	0.43	0.09	0.00	0.07	0.02	0.00++
2	0.00	0.14**	0.00	0.02	0.12	0.20++	0.00	0.00	0.35	0.00	0.00	0.00
3	0.95	0.04	0.00	0.00	0.00	0.12	0.00	0.00	0.15	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.05	1.20	0.00+	0.00	0.00	0.00	0.00
5	0.00	0.00	0.05	0.00	0.00+	T	0.30	0.00	0.27	0.00	0.00	0.00
6	0.00	0.20	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.68	0.00	0.08	0.70	0.00	0.94	0.00	1.54
8	0.40	0.00	0.00+	0.00	T	0.00	0.00	0.20	0.00	0.06	0.00	0.14
9	0.00	0.00	0.62	0.00	0.00	0.00+	0.32	0.00	0.00	0.56	0.00	0.00
10	0.00	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.22	0.00	T	0.00
11	T	0.10	0.00	0.00	0.30	0.00	0.00++	0.00	0.00	0.00	0.00	0.00
12	0.56	0.05	T	0.15	0.10	0.00	0.00	0.00	0.00	0.00+	0.20	0.82
13	0.31	0.02	0.32	0.00+	0.00	0.00	0.23	0.00	0.00+	0.00	0.00	0.10
14	0.47	0.02	0.00	0.00	0.28	0.00	0.00+	0.00	T	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	2.12	0.00	0.00	0.00	0.00	0.00	0.14	0.28
16	0.00	0.00	0.12	0.00	0.38	0.00	0.25	0.45	0.04	0.00	0.00	0.05
17	T	0.00	0.05	0.00	0.08	0.00	0.80	0.00	0.00	0.16	0.00	0.00
18	0.00	0.69	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	1.02	0.00	0.00	0.35	0.25	0.00	0.00	0.00	0.00	0.00	0.00
20	T**	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.00	0.00	0.28
21	0.00	0.00	0.47	T	0.00	0.71	0.02	0.00	0.39	0.58	0.00	0.29
22	0.00	0.53	0.00	0.19	0.00	T	0.00	0.00	0.00	0.00	0.00	0.00
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00
25	0.84	0.00	0.27	0.20	0.00	0.00	0.00	0.00	0.00	1.08	0.00	0.00
26	0.96	0.00	0.00	0.03	0.00	T	0.00	0.19	0.00	1.30	0.00	0.49
27	0.87	0.00	0.32	0.00	0.00	0.63	0.00	0.31	0.78	0.00	0.60	0.00
28	T	0.00	0.06	0.00	0.06	T	0.00	0.94	1.18	0.00	0.38	0.00
29	0.00	0.00	0.00	0.00	1.60	0.39	0.00	0.00	0.00	0.00	1.30	0.00
30	0.00	X	1.95	0.00	1.42	0.76	0.00	0.07	0.07	0.12	0.00	0.00
31	0.00	X	0.11	X	0.00	X	T	0.00	X	0.84	X	0.54
Total	5.98	2.99	5.36	0.69	8.15	3.81	3.63	2.95	3.45	5.83	2.64	4.53
Snow	T	T										

TABLE C.4
(Continued)

Day	1977 Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.04	T	0.15
2	0.00	0.00	0.00	0.00	0.25	0.00	0.11	0.05	0.00	0.27	0.00	0.00
3	0.00	0.00	0.06	1.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.03**	0.00	0.37	1.75	0.55	0.00	0.00	0.00	0.00	0.00	0.08	0.34
5	0.16	0.00	0.00	2.57	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.26
6	0.00	0.00	0.42	0.08	0.00	0.00	0.00	0.00	1.03	0.00	1.02	0.47
7	0.43	0.00	0.08	0.00	0.00	0.03	0.00	0.00	0.0-+	0.00	0.04	0.00
8	0.00	0.00	0.00	0.00	1.05	0.00+	0.00	0.05	2.14	0.08	T	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.02	2.02	0.00	0.80
10	0.70	0.00	0.00	0.00	0.00+	0.00	0.00	0.84	0.00	0.00	T	0.00
11	0.00+	0.00	0.00	0.00	0.00	0.00	0.00	0.28+	0.00	0.00	0.00	0.00
12	0.00	0.00	T	0.00+	0.00	0.00	0.00	0.00	0.00	0.00+	0.00	0.00
13	0.00	0.39	2.21	0.00	0.00	0.37	0.16+	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.05	0.46	0.00	0.00	T
15	0.41	0.00	0.00+	0.00	0.00	0.07	0.00	0.13	0.55	0.00	0.00	0.20
16	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.06	0.18	0.25	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	T	0.00	0.23	0.58	0.00	0.80	0.00
18	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.51	0.28	0.00	0.00	0.60
19	0.00	0.00	0.00	0.00	0.14	0.20	0.00	0.00	0.00	0.00	0.00	0.00++
20	0.02**	0.00	0.42	0.07	0.02	0.43	0.00	0.00	0.72	0.00	0.00	T
21	T	0.00	0.00	0.00	0.26	0.18	0.00	0.00	0.00	0.00	0.10++	0.00
22	0.00	0.00	0.29	0.00	0.06	0.00	0.00	0.00	0.00	0.00	1.20	0.00
23	0.00	0.00	0.00	0.54	0.34	1.23	0.18	0.00	0.00	0.00	0.95	0.00
24	0.02**	0.72	0.00	0.16	0.62	0.30	0.00	0.00	0.00	0.00	0.02	0.00
25	0.05**	0.00	0.00	0.00	0.20	0.28	0.00	0.92	0.00	0.02	0.00	1.62
26	0.04	0.00	0.00	0.00	0.00	0.32	1.03	0.00	0.00	2.10	0.00	0.00
27	0.16	0.58	0.00	0.00	0.00	1.15	0.00	0.00	0.00	0.00	0.00	0.00
28	0.00	0.08	0.00	0.00	0.00	0.00	0.00	T	0.00	0.00	0.34	0.00
29	0.00	X	0.25	T	0.00	0.00	0.00	0.00	0.00	0.00	1.02	0.00
30	0.00	X	1.17	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.13	T
31	0.00	X	0.14	X	0.00	X	0.00	0.00	X	0.00	X	0.22
Total	2.02	1.77	5.41	6.17	3.76	5.22	1.58	3.55	6.03	4.78	5.82	4.66
Snow	5.3											

TABLE C.4
(Continued)

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
	1978									
1	0.00	0.00	0.00	0.00	0.60	0.00	0.00	1.74	0.00	0.52
2	0.03	0.10**	0.28	0.00	0.05	0.00	1.02	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.48	0.97	0.00	0.00	0.00
4	0.00	0.00	0.55**	0.00	0.75++	0.04	0.00	0.00	0.00	0.25
5	0.00	0.00	0.00	0.03	0.13	0.00	0.00	0.70	0.00	0.00
6	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.00	0.00
7	0.05	0.00	0.00	0.00	0.00	T	0.00	0.16	0.00	0.00
8	0.00	0.00	0.29	0.00	0.30	1.61++	0.00	0.02	0.00	0.00
9	1.56	0.00	0.41	0.00	1.14	2.19	0.00	0.08	0.00	0.00
10	0.00	0.00	1.08	0.00	0.00	0.00	0.14	0.26	0.00	0.00
11	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.89++	0.00
12	0.00	0.00	0.06	0.29	0.00	0.00	0.00	2.15	0.00	0.00
13	0.60**	0.02	0.44	0.00	0.86	0.74	0.00	0.46	0.00	0.00
14	0.00	0.27	0.83	0.00	0.11	0.00	0.00	0.61	0.00	0.07
15	0.10**	0.00	T	0.00	0.20	0.00	0.00	0.00	0.16	0.00
16	0.00	0.00	0.00	0.00	0.02	0.00	1.78	0.14	0.00	0.00
17	0.30	0.04	0.00	T	0.00	0.00	1.12	0.07	0.00	0.00
18	0.93	0.02	0.05	0.05++	0.00	0.00	0.00	0.00	0.00	0.00
19	0.05	0.00	0.00	1.25	0.00	0.00	0.00	0.00	0.00	0.00
20	0.74**	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00
21	0.00	0.00++	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00
22	0.00	0.30**	0.38	0.07	0.00	0.05	0.00	0.00	0.00	0.00
23	0.06++	T**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	0.00	0.20	0.00	0.00	0.90	0.00	0.04	0.00	T	0.00
25	0.68	0.00	0.05	0.06	0.38	0.00	0.48	0.62	0.00	0.00
26	1.30	0.00	0.43	0.87	0.47	0.00	1.26++	0.00	0.00	0.00
27	0.00	0.00	0.02	0.09	0.00	0.00	0.00	0.00	0.00	0.07
28	0.00	0.15**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29	0.00	X	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	X	0.00++	0.00	0.00	0.00	0.00	T	0.00	0.00
31	0.00	X	0.00	X	0.00	X	0.00	0.38	X	0.00
Total	6.64	1.10	4.87	2.87	5.91	5.58	6.81	7.81	1.05	0.91
Snow	5.0		0.5							

*Precipitation in inches for 24-hour period ending 12 midnight on date indicated.
**Snow or snow and rain mixed.
+Denotes days when routine water quality surveys were conducted.
++Denotes days when special stormwater runoff surveys were conducted.

Appendix D

Analytical and Sample Preservation Methods for Chemical Parameters

TABLE D.1

ANALYTICAL AND SAMPLE PRESERVATION METHODS FOR CHEMICAL PARAMETERS, CRBRP

Parameter	STORET Code Number[1]	Method and Reference[2]	Preservation Techniques	Detection Limits
Alkalinity, total mg/l as $CaCO_3$	00410	Potentiometric Titration Standard Methods, pp. 52, 370	Field determination	1 mg/l
Alkalinity, Phenolphthalein mg/l as $CaCO_3$	00415	Potentiometric Titration Standard Methods, pp. 52, 370	Field determination	1 mg/l
Biochemical Oxygen Demand mg/l	00310	DO depletion at 20°C for 5 days measured with YSI Model 54 RC Standard Methods, p. 489 and EPA, p. 11	Cool, 4°C	1 mg/l
Cadmium µg/l	01027	Atomic Absorption EPA, pp. 81, 89, 101	1+1 HNO_3 1 ml/8 oz.	1 µg/l
Calcium mg/l	00916	Atomic Absorption EPA, pp. 81, 103	1+1 HNO_3 1 ml/8 oz.	1 mg/l
Carbon, dissolved organic mg/l	00681	Combustion - Infrared EPA, p. 236	1+4 H_2SO_4, 4°C 1 ml/8 oz.	0.2 mg/l
Carbon, total organic mg/l	00680	Combustion - Infrared EPA, p. 236	1+4 H_2SO_4, 4°C 1 ml/8 oz.	0.2 mg/l
Chemical Oxygen Demand mg/l	00335	Titrimetric - $K_2Cr_2O_7$ reflux EPA, p. 20	1+4 H_2SO_4, 4°C 1 ml/4 oz.	1 mg/l
Chloride mg/l	00940	Titrimetric EPA p.29	4°C	1 mg/l
Chromium µg/l	01034	Atomic Absorption EPA, pp. 81, 89, 105	1+1 HNO_3 1 ml/8 oz.	5 µg/l
Coliform, total No./100 ml	31501	Membrane filter, Standard methods, p. 679	Cool, 4°C	1 $\frac{\text{organism}}{\text{100 ml}}$
Coliform, fecal No./100 ml	31616	Membrane Filter, Standard methods, p. 684	Cool, 4°C	1 $\frac{\text{organism}}{\text{100 ml}}$
Color, apparent PCU	00081	Visual Comparison EPA, p. 36	Cool, 4°C	1 PCU
Color, true PCU	00080	Visual Comparison EPA, p. 36	Cool, 4°C	1 PCU
Conductance, specific µmhos/cm @ 25°C	00095	Wheatstone Bridge or Equivalent EPA, p. 275	In Situ	0.5 µmho/cm
Copper µg/l	01042	Atomic Absorption EPA, pp. 81, 108	1+1 HNO_3 1 ml/8 oz.	10 µg/l
Hardness, total mg/l	00900	Calculated from Ca and Mg values	None	3 mg/l
Iron, total µg/l	01045	Atomic Absorption EPA, pp. 81, 110	1+1 HNO_3 1 ml/8 oz.	50 µg/l
Iron, dissolved µg/l	01046	Atomic Absorption EPA, pp. 81, 110	1+1 HNO_3 1 ml/8 oz.	50 µg/l
Iron, ferrous µg/l	01047	Colorimetric Standard Methods, p. 189	Hydrochloric Acid 5 ml/8 oz.	10 µg/l
Lead µg/l	01051	Atomic Absorption EPA, pp. 81, 89, 112	1+1 HNO_3 1 ml/8 oz.	10 µg/l

TABLE D.1
(Continued)

Parameter	STORET Code Number[1]	Method and Reference[2]	Preservation Techniques	Detection Limits
Magnesium mg/l	00927	Atomic Absorption EPA, pp. 81, 114	1+1 HNO_3 1 ml/8 oz.	0.1 mg/l
Manganese, total µg/l	01055	Atomic Absorption EPA, pp. 81, 116	1+1 HNO_3 1 ml/8 oz.	10 µg/l
Manganese, dissolved µg/l	01056	Atomic Absorption EPA, pp. 81, 116	1+1 HNO_3 1 ml/8 oz.	10 µg/l
Mercury µg/l	71900	Flameless Atomic Absorption EPA, p. 118	1+1 HNO_3 1 ml/8 oz.	0.2 µg/l
Nickel µg/l	01067	Atomic Absorption EPA, pp. 81, 89, 141	1+1 HNO_3 1 ml/8 oz.	5 µg/l
Nitrogen, ammonia mg/l	00610	Colorimetric EPA, p. 168	1+4 H_2SO_4, 4°C 1 ml/8 oz.	0.01 mg/l
Nitrogen, nitrate plus nitrite mg/l	00630	Colorimetric EPA, p. 207	1+4 H_2SO_4, 4°C 1 ml/8 oz.	0.01 mg/l
Nitrogen, organic mg/l	00605	Calculated from kjeldahl nitrogen minus ammonia nitrogen, colorimetric-automated digestion and phenate, EPA, p. 168, 182	1+4 H_2SO_4, 4°C 1 ml/8 oz.	0.01 mg/l
Oxygen, dissolved mg/l	00300	Electrode and/or Titrimetric EPA, pp. 51, 56	In Situ	0.01 mg/l
pH units	00400	Potentiometric EPA, p. 239	In Situ	Not Applicable
Phosphorus, total mg/l	00665	Colorimetric EPA, pp. 249, 256 (with TVA modification)	1+4 H_2SO_4, 4°C 1 ml/8 oz.	0.01 mg/l
Phosphorus, dissolved mg/l	00666	Colorimetric EPA, p. 249 (with TVA modification)	Cool, 4°C	0.01 mg/l
Potassium mg/l	00937	Atomic Absorption EPA, pp. 81, 143	1+1 HNO_3 1 ml/8 oz.	0.1 mg/l
Residue, total filterable mg/l	70300	Gravimetric EPA, p. 266	Cool, 4°C	10 mg/l
Residue, total nonfilterable mg/l	00530	Gravimetric EPA, p. 268	Cool, 4°C	1 mg/l
Silica, dissolved mg/l	00956	Colorimetric EPA, p. 274	Cool, 4°C	0.1 mg/l
Sodium mg/l	00929	Atomic Absorption EPA, pp. 81, 147	Cool, 4°C	0.1 mg/l
Sulfate mg/l	00945	Turbidimetric EPA, p. 277	Cool, 4°C	1 mg/l
Temperature °C	00010	Thermistor, Thermometer	In Situ	0.1°C
Turbidity JTU(NYU)	00076	Nephelometric EPA, p. 295	Cool,4°C	1 JTU(NTU)

TABLE D.1
(Continued)

Parameter	STORET Code Number[1]	Method and Reference[2]	Preservation Techniques	Detection Limits
Zinc µg/l	01092	Atomic Absorption EPA, pp. 81, 155	1+1 HNO_3 1 ml/8 oz.	10 µg/l

[1]STORET is the acronym for EPA's data storage and retrieval system, on which all TVA data is entered.
[2]Reference abbreviations refer to the following:

EPA - Methods for Chemical Analysis of Water Wastes, 1974, Environmental Protection Agency, Water Quality Office, Cincinnati, Ohio.

Standard Methods - Standard Methods for the Examination of Water and Wastewater, 14th Edition, 1975, American Public Health Association, New York, NY.

USGS - Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gases, Book 5 - Chapter A-1, 1970, U.S. Department of Interior, Geological Survey.

Water Research - "Automated Analysis for Nitrate by Hydrazine Reduction" Water Research, 1, 205, 1967.